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ORIGINAL ARTICLES.

I.—On *Eryon antiquus*, Broderip, sp., from the Lower Lias, Lyme-Regis, Dorset.

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(PLATE XII.)

So far back as the year 1820, Schlotheim described in his Petrefactenkunde, vol. i. p. 37, certain Oolitic Crustacea from Solenhofen, which he called *Macrourites;* but forms belonging to more than one genus were included by him under this name.

We are indebted to M. Desmarest, in 1822, for the earliest description of the genus *Eryon* from the Lithographic Stone of Solenhofen.[1]

A form of *Eryon* was described in 1835, from the Lias of Lyme-Regis, by Mr. W. J. Broderip,[2] F.R.S., under the name of *Coleia antiqua*. In the same year Prof. von Meyer described an *Eryon* from the Upper Lias of Rabenstein, Bavaria, under the name of *E. Hartmanni*.[3]

In 1849 Prof. McCoy[4] described, but did not figure, an *Eryon* from the Lias of Leicestershire under the name of *E. Barrovensis*.

Ten species of *Eryon* have been described by Schlotheim,[5] Münster,[6] Etallon,[7] Germar,[8] Fraas[9] and Oppel,[10] mostly from the Lithographic Stone of Solenhofen. *Eryon*[11] *Escheri* was described by Oppel from the Lower Lias of Schambelen, Switzerland, and *Eryon Edwardsi* by M. Morière,[12] from the U. Lias of Calvados, Normandy.

In 1866 I described and figured several British Liassic species of *Eryon*,[13] viz —*E. Barrovensis, E. Wilmcotensis, E. Brodiei, E. crassichelis*, and *E. Moorei;* also *E. Oppeli* from Solenhofen.

In 1881 I added another British species of *Eryon*, *E. Stoddarti*,[14] from the Stonesfield Slate, and *E. Neocomiensis*,[15] from the Lower Cretaceous of Silesia.

[1] Nat. Hist. Foss. Crust. 1822, p. 128.
[2] Trans. Geol. Soc. 1835, 2nd ser. vol. v. p. 172, pl. 12, figs. 1 and 2.
[3] Brown, Jahrb. 1836, p. 329.
[4] Ann. Mag. Nat. Hist. 1849, p. 172.
[5] Petrefactenkunde, 1822, p. 35, tab. 3, fig. 2.
[6] Beitrage zur Petrefk. 1839, vol. ii. p. 2.
[7] Etallon in Bullet. Soc. Geol. de Fr. 1858, xvi. p. 169, t. 4, figs. 1–3.
[8] Germar in Keferstein. Deutschl. 1827, iv. p. 99.
[9] Württemb. naturw. Jahresh. 1855, xi. Jahrg. p. 94.
[10] Pal. Mittheil. 1862, p. 8, tabs. 1–3.
[11] Pal. Mittheil. 1862, p. x. t. 1, fig. 1.
[12] Bull. Soc. Linn. de Normandie, 1864, tome viii. p. 89, pl. vi.
[13] Quart. Journ. Geol. Soc. 1866, vol. xxiii. p. 493, pl. xxiv. and xxv.
[14] Geol. Mag. 1881, p. 529, Pl. XIV. Fig. 2.
[15] Geol. Mag. 1881, p. 530, Pl. XIV. Fig. 1.

In 1883 M. Morière described a second species of *Eryon* under the name of *E. calvadosi*[1] from the Upper Lias of Calvados.

In 1884 Mr. C. Spence-Bate, F.R.S., figured and described a species of *Eryon* from the Lias of Lyme-Regis, Dorset, under the name of *Archæastacus Willemœsii*.[2] I ventured to point out, in a footnote to his paper (see Geol. Mag. 1884, p. 310) that the specimen so described was almost certainly identical with *Eryon crassichelis*, H. Woodw., 1866 (see Quart. Journ. Geol. Soc. 1866, vol. xxii. p. 497, pl. xxv. fig. 2).

In August, 1888, the two fine volumes xxiv. (text and plates) of the "Challenger" Report on the Crustacea-Macroura by Mr. C. Spence-Bate, F.R.S., were received by me. In this magnificent Monograph the author discusses, under "Morphology," p. xv, and again under the *Eryonidæ* (pp. 100–120), both the past and present representatives of this family, and he gives a conjectural restoration of his "*Archæastacus Willemœsii*" (? = *Eryon crassichelis*, H. Woodw.), which, however, differs considerably from the actual specimen, as may be seen by a comparison of the carefully-drawn Plate X. Geol. 1884, Mag. with the "Challenger" woodcut on p. 117.

The most important points to be noticed in the *new figure* are, the omission of the articulation (*diæresis*) in the outer lamella (exopodite) of the sixth segment of the abdomen (forming the "*rhipidura*," or "tail-fan" of Spence-Bate); the exaggerated size of the *scaphocerite* or antennal scale—certainly more than twice the natural size; and the incorrect representation of the basal joints of the antenna. This latter is due to Mr. Spence-Bate having mistaken the three terminal joints of the exopodite of the maxillipede (preserved in the fossil on the right side) for the basal joints of the antenna. The antennules in the original specimen do not bend outwards over the antenna as here represented, the former with their short bifid multiarticulate flagella being directed forwards, and the latter with its single flagellum, and short ovoid basal scale, being curved *outwards*. Lastly, it is quite certain that the latero-anterior margin of the carapace is not perfect in the fossil, and does not justify the representation given of a smooth rounded margin; the evidence on the surface of the carapace of a cervical furrow bifurcating on each side justifies the assumption that the margin would be intersected by two indentations one at the end of each branch of the cervical furrow, and marked by a more or less pointed lobe enclosed between these two indentations, a form of carapace most characteristic of the genus *Eryon*.

In 1835 Mr. W. J. Broderip described in the Transactions of the Geological Society of London (2nd series, vol. v. pl. 12, figs. 1, 2, p. 172), a new Macrourous Decapod Crustacean from the Lias of Lyme-Regis, which he named *Coleia antiqua*. The larger fossil figured by Broderip is very imperfect, but the smaller is more complete; both examples display sufficient evidence in the carapace and appendages to have justified Dr. Oppel in his conclusion that they belonged to the genus *Eryon* (Pal. Mittheil. 1862, p. 11).

[1] Bull. Soc. Linn. de Normandie, 1883, sér. 3, tome vii. pp. 1–10, pl. i.–iii.
[2] Geol. Mag. 1884, Dec. III. Vol. I. Pl. X. p. 307.

Another example of *Eryon* (*Coleia*) *antiquus* from the same locality and formation having been obtained for the British Museum, it seems to me to deserve to be recorded and figured (see Plate XII.), as this is evidently a rather rare species in our Lias.

Description.—The whole specimen measures 11½ centimètres in length; the cephalothorax is 5¼ centim. long and 5 c. at its broadest part just behind the cervical furrow, and 4 c. wide at its posterior border. The hinder border is nearly straight, being but slightly arched, or concave, forwards. At a distance of 3 c. from the posterior border there is a well-developed rather incurved tooth or spine marking the posterior margin of the first lateral indentation of the carapace 5 mm. deep. At 3¾ centimètres from the posterior border the 2nd lateral roundly-incurved tooth arises. Here the carapace becomes narrower, being only 4¼ c. in breadth. This 2nd rounded serration also marks the second lateral indentation 6 mm. deep; this may be called the cervical notch, as it unites with the cervical furrow, which here crosses the carapace in a clearly-marked obtusely V-shaped line. In front of this cervical notch, the carapace again expands, forming a rounded lobe on each side, ending in a third antero-lateral tooth; here the carapace has contracted to a breadth of 2½ centimètres; this tooth forms the outer border of the orbital fossa 6 mm. broad; the inner margin of which is formed by a spine 6 mm. long, which rises up on either side of the deep frontal fossa, 12 mm. across, and broadly U-shaped, which occupies in the carapace of *Eryon* that space usually filled by the rostrum in other Macroura, but which is not developed in the *Eryonidæ*.

In this frontal fossa the antennules are seen with their three basal joints and their bifid flagella, the outer flagellum being 11 mm. long and the inner 16 mm. Just inside the antennules are preserved the four distal joints of the two palpi (or endopodites) of the 3rd or external pair of maxillipedes. Only portions of the flagella of the outer antenna with their basal joints are preserved. Near the base of these, the flattened remains of the ophthalmopods are seen lying in the orbital fossa on each side.

The great length of the first pair of chelate thoracic legs is very characteristic of *E. antiquus*, and strikingly in contrast with all the other species of *Eryon*, save *E. bilobatus*, *E. longipes*, and *E. Redenbacheri*, from Solenhofen (see Oppel's Pal. Mittheil. pp. 16–18, tab. 3, figs. 2, 3, 6). They are, in our fossil, 11½ centimètres long. The 2nd pair, also chelate, are much smaller, being 4½ c. long. The 3rd and 4th pairs were also chelate and the 5th pair simple.

The abdomen measures 6¼ centimètres in length, including the telson, which is 2 c. long. Its widest part is at the 2nd segment, which is 3½ c. wide, the 6th being 2½ c.: the breadth of the swimmerets of the tail is 6¼ c. The telson is 14 mm. broad. The sternal arches of the segments are narrow near the centre, with wide intersternal membranes; but they become broader near their rounded epimeral borders.

Each somite or segment bears upon the centre of its tergal arch a strong tubercle; the whole surface of the segments being coarsely

granular. The telson has three longitudinal ridges upon it. The tail-lobes or swimmerets are broadly rounded, and the outer plate has a diæresis across its lower extremity. The surface of the carapace is strongly granulated, the centre or dorsal line being marked by a strong line of tubercles which die out forwards, just beyond the cervical furrow. In addition to the dorsal ridge two lateral lines of smaller tubercles further subdivide the carapace longitudinally, marking off the branchial region on either side. The lateral margins of the carapace are also marked by minute spines and tubercles.

Referring again to Mr. C. Spence-Bate's remarks on the genus *Eryon*, including as at present constituted many species from the Solenhofen Limestone in which the diæresis, or suture dividing the outer lobe of the caudal fin, is absent, and many from the English Lias, etc., in which it is distinctly present, Mr. Spence-Bate contends —and he is probably justified in his contention—that the absence or presence of this diæresis is of generic, if not of family, value; and further that there are many other distinctive characters amongst the various species of *Eryon* which are of sufficient importance to constitute generic differences. He has separated from the genus *Eryon*, under the name of *Archæastacus Willemœsii*, a Liassic form from Lyme-Regis (see Geol. Mag. 1884, Pl. X. and p. 307; see also "Challenger" volume, 1888, p. 117), which he believed had *no diæresis*, but which has in fact a well-marked one. Apart from this, it has no salient character which would entitle it to be treated as generically distinct from other Liassic forms of *Eryon*. But if the presence or absence of a *diæresis* in the outer lobe of the tail-fan be deemed of generic value, then all those forms *in which this suture is absent*, must be retained in the genus *Eryon*,[1] whilst those in which a *diæresis* is present, must form a new genus.

Unfortunately the name *Archæastacus*, proposed by Mr. Spence-Bate, cannot stand, as it was given in error to a form which its author believed to be destitute of a *diæresis*, whereas it possesses one. But if the Liassic species must be separated for this reason from the genus *Eryon*, then Broderip's genus *Coleia* (1835) should be revived, as having the priority, by more than fifty years, over the generic name proposed by Spence-Bate.

Mr. Spence-Bate quotes the writer as to the rarity with which the eyes are found preserved in fossil forms of the genus *Eryon*. He writes: "The eye is but rarely if ever preserved, and Woodward says, '*has never been positively determined*,' and the peduncle on which it is supposed to stand frequently appears as if it were biarticulated; but I have never seen a specimen, or the figure of one, in which the perfectly-formed eye has been found so as clearly to determine its form and character."

I cannot find the above italicized quotation, but I do say (Quart. Journ. Geol. Soc. 1866, p. 496): "The eyes, but rarely preserved, are placed"—in *Eryon Barrovensis*—"near the base of the scale of the outer antennæ." Again under *E. Brodiei* (op. cit. p. 498): "In this specimen, one eye is preserved *in sitû*."

[1] The genus *Eryon* was founded by Desmarest on specimens from Solenhofen which have *no diæresis* in the tail-fan.

In Oppel's "Palæontologische Mittheilungen" (1862) he figures several *Eryon* from Solenhofen; e.g. *E. arctiformis*, Schlot. sp. (*op. cit.* Tab. 3, fig. 1), and he marks (*o*, *o*) "Augenstiele," and on Tab. 2, figs. 1, 2, 3 (*o*, *o*) "Einschnitte im Cephalothorax für die Augen." In the description of the figure given by him ("Challenger" Report, p. xv) of *Eryon calvadosii* (after M. Morière) "the orbits," says Spence-Bate, "for the reception of the organs of vision are well preserved." Bearing in mind the usually delicate nature of these organs, it is not surprising to find them more often represented by their orbital vacuities than by the eyes themselves.[1]

We cannot follow Mr. Spence-Bate in his conclusions that we find "in the same geological epoch some specimens of *Eryon* that are *blind*, and others with large and probably well-developed organs of vision" (*op. cit.* p. xvi). Such a deduction, based upon our present imperfect knowledge of fossil forms, would be as erroneous as to conclude that the Venus of Milo was originally sculptured without arms because they are now reduced to stumps.

During the cruise of the "Challenger," two genera of deep-sea Crustaceans allied to *Eryon* were obtained by Dr. v. Willemoes-Suhm, the late talented Naturalist to the Expedition, whose lamented death occurred before the completion of the voyage.

By the kindness of Dr. John Murray, F.R.S.E., the Director of the "Challenger" publications, I am permitted to reproduce figures of these very remarkable living representatives of this well-marked and ancient family of Jurassic Crustaceans.

The first of these, *Polycheles crucifera*, was dredged off Sombrero Island, West Indies, in a depth of 480 fathoms (*op. cit.* p. 127). Another specimen is mentioned (at p. 100) as having been dredged in the middle of the North Atlantic at a depth of 1900 fathoms, or rather more than two miles from the surface! (see Woodcut, Fig. 1).

"The eye is lodged in a narrow cleft of the dorsal surface of the carapace, and projects beneath the antero-lateral angle of the carapace in the form of an obtuse point" (*op. cit.* p. 127). "The animal," says Mr. Spence-Bate, "can have had only a very limited range of vision outwardly, by the aid of one lens above, and another below and a little in advance, and even this, from the apparent density of the cornea, must have been of a very imperfect character" (*op. cit.* p. 128).

Another species, *Polycheles Helleri*, Bate, dredged to the north of New Zealand, in a depth of 520 fathoms, and again north of New Guinea, at a depth of 1070 fathoms, appears to have had equally imperfect vision (*op. cit.* p. 139).

The second form, *Pentacheles euthrix* (Woodcut, Fig. 2), was dredged off the Kermadec Islands in depths of 520 and 630 fathoms; and again off Matuku, in 315 fathoms.

"The ophthalmopod is lodged in a notch in the carapace that is

[1] In the recent forms described by Mr. Spence-Bate the eye was found to be almost entirely concealed beneath the antero-lateral angle of the carapace, see woodcut of ophthalmopod of *Pentacheles gracilis* ("Challenger" Report, or Crustacea-Macroura, vol. xxiv. p. 114, fig. 28; also vol. xxiv. plate xvii. figs. C *a*, C ii. *a*, C iii. *a*.)

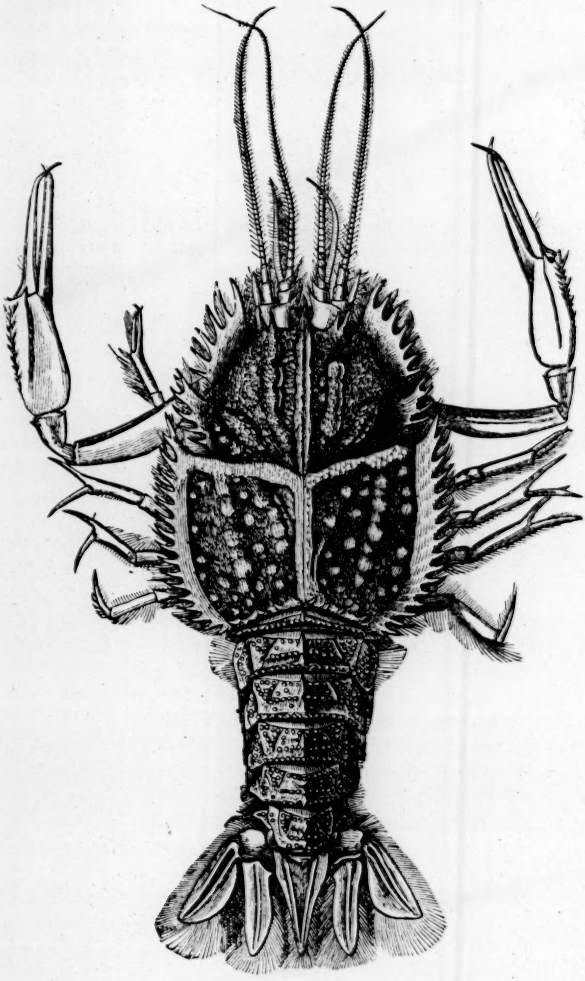


FIG. 1. *Polycheles crucifera.*

From a drawing by Dr. v. WILLEMOES-SUHM.

(Reproduced by permission from the "Challenger" Report on Crustacea-Macrura, vol. xxiv. p. 131, fig. 31.)

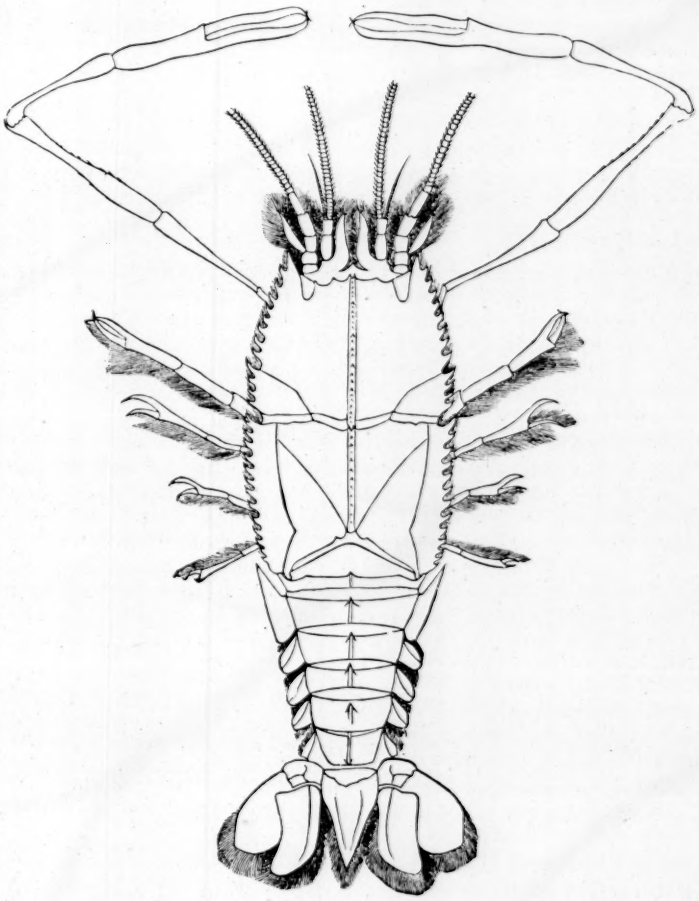


FIG. 2.—*Pentacheles euthrix.*

From a drawing by Dr. v. WILLEMOES-SUHM.

(Reproduced by permission from the "Challenger" Report on Crustacea-Macrura, vol. xxiv. p. 150, fig. 33.)

much broader at the anterior margin, and narrower posteriorly; it carries a small, pointed cusp on the anterior surface, and passes outwards beneath the projecting angle of the carapace, and terminates in two small nodules, one on the outer, and the other on the lower side" (*op. cit.* p. 151).

Three other species are recorded by Mr. Spence-Bate, viz.—*P. obscura*, north of New Guinea, depth 1070 fathoms; *P. lævis*, between Samboagan and New Guinea, 500 fathoms; *P. gracilis*, off Kandavu Island, in 610 fathoms.

It can hardly be doubted that in these remarkable deep-sea forms we have the last survivors of a once numerous family of Crustacea-Macrura with broad and flattened carapaces, destitute of any rostrum, serrated more or less along their lateral margins, and generally marked by a strong cervical furrow which is usually branched laterally.

That these modern forms should either be quite blind, or have but imperfect vision, does not seem extraordinary when we consider the very great depth at which they have been found living; but it is quite certain that the fossil forms, both of the Oolite and Lias, inhabited comparatively shallow near-shore waters, as is proved by the nature of the deposits in which they occur, and the numerous terrestrial and shallow-water organisms found embedded with them.

The absence of vision in the fossil forms cannot therefore be proved by comparing them with the recent ones, whose conditions and surroundings are so different. The species of *Eryon* from the Lias, having all, apparently, a *diæresis* in the outer lobe of the caudal fan, are evidently an older or less specialized form than those of the newer Solenhofen Stone (Upper Oolite), in which the *diæresis* is absent, the outer lobe of the caudal fan being in one piece; and this is the case also in the surviving deep-sea species.

In a footnote to the "Challenger" Report on *Crustacea-Macrura*, Mr. Spence-Bate writes at p. 120:—"In the Quart. Journ. Geol. Soc. (1866) vol. xxv. fig. 1, Dr. Woodward delineated by the help of the fine examples in the cabinet of the Rev. P. B. Brodie, F.G.S., and those in the British Museum, a completely restored figure of *Eryon barrovensis*, M'Coy, in which the scaphocerite is fixed at the extremity of a peduncle that is independent of that of the antennæ. This condition not being in accordance with the anatomical structure of the Macrurous Decapoda, I am induced to think that the small pedicular plate at the extremity of the third pair of maxillæ is intended, of which a drawing is given, fig. 31, p. 135, in this Report, and which in some recent species extends beyond the frontal margin." In my figure referred to, the artist has correctly represented the projecting latero-anterior angles of the frontal margin of the carapace of *E. Barrovensis* as partially concealing the broad basal joint of the antenna, giving to it *the appearance* as if the antennal scale (scaphocerite) was articulated to a distinct base, separate from the antenna. As such a structure is unknown, it is extraordinary that this should have misled so old and experienced a Carcinologist as Mr. Spence-Bate, and that he should not have turned to the text, where (p. 496,

op. cit.) it is distinctly stated that, "Each of the outer antennæ has a large oval scale attached to its broad basal joint."

It would be quite impossible, in the scope of the present brief article, to discuss the numerous points of interest and importance bearing upon the *Eryonidæ* which the publication of Mr. Spence-Bate's fine Monograph raises, but, I may mention, that in an early Palæontographical Monograph on the British Liassic Crustacea, I hope to treat this subject with the fullness which it deserves.

II.—Fossil Arctic Plants from the Lacustrine Deposit at Hoxne, in Suffolk.[1]

By Clement Reid, F.G.S., and H. N. Ridley, M.A., F.L.S.

NEAR the village of Hoxne, close to the northern border of Suffolk, and about five miles east of Diss, lies the well-known lacustrine deposit from which Palæolithic implements were obtained more than 90 years ago. This deposit has been so well described that it may seem presumptuous to imagine that there is still anything new to be said about it. But it so happens that every observer up till now has studied the deposit either from an archæological or from a geological point of view. No one has paid special attention to the character of the associated plants, or to the climatic conditions which these plants indicate.

The earliest description of the deposits at Hoxne is an excellent one contained in a letter by John Frere to the Secretary of the Society of Antiquaries.[2] This is dated as far back as 1797. It gives a clear account of the exact mode of occurrence of the implements, and enables us to recognize without difficulty the relative position of the implement-bearing deposits, and of the beds with arctic plants described in this paper.

The section given by Frere is:—

1.	Vegetable earth	1½ feet.
2.	Argill	7½ ,,
3.	Sand mixed with shells and other marine[3] substances	1 foot.
4.	A gravelly soil, in which the flints are found, generally at the rate of five or six in a square yard	2 feet.

"In the same stratum are frequently found small fragments of wood, very perfect when first dug up, but which soon decompose on being exposed to the air; and in the stratum of sand (No. 3) were found some extraordinary bones. . . . ." Frere also alludes to the underlying "tract of boggy earth" under No. 4.

The next geological paper dealing with the Hoxne deposit was not published till 1860.[4] In that and the previous year Professor Prestwich visited Hoxne, and very thoroughly worked out the stratigraphical relations of the different beds. To this paper and to a later one published in 1864,[5] we must refer readers for a full

[1] Read at the British Association, Section C, Bath, September, 1888.
[2] Archæologia, vol. xiii. p. 204, 1800, two pp. and two 4to. plates of implements.
[3] This is a mistake, the shells, etc., are freshwater.
[4] Phil. Trans. vol. cl. pp. 304–308, pl. xi.
[5] *Ibid.* cliv. p. 283.

account of the geology, merely quoting one of Prof. Prestwich's sections as an example of the rest, to show which bed contains the Arctic plants:—

Section in S.W. corner of Hoxne Brick-field, 1859.

	feet.
a. Surface soil, traces of sand and gravel	1 to 2
b. Brown and greyish clay, not calcareous, with an irregular central carbonaceous or peaty seam. Two flint-implements. Bones of *Bos*.	10 to 12
c. Yellow sub-angular flint-gravel, with a certain proportion of small chalk pebbles, and a few pebbles of siliceous sandstone, quartz, and other old rocks. *Elephas*. The matrix of this bed, in places, consists of clay like *b*	½ to 1
d. Bluish and grey calcareous clay, in places very peaty; lower part with seams or partings of sand. *Wood* and vegetable remains. Land and freshwater *shells*. Bones of *Mammalia* (Deer, Horse, Elephant).	3 to 4
e. Gravel like *c*, but smaller, more worn, and with more chalk pebbles	1 to 2½
f. Calcareous grey clay, more or less peaty, with freshwater *shells* (bored to 17 feet, but no bottom was reached)	17

Other sections showed that the whole deposit rested on Boulder-clay.

From bed *d* Prof. Prestwich obtained wood of Oak (?),[1] Yew and Fir, and subsequently some leaves "apparently of Bilberry" (these belong really to *Salix myrsinites*). He also records the following species of land and freshwater mollusca:—

Pisidium amnicum, Müll.
Sphærium corneum, Linn.
Unio (fragmentary).
Arion ater, Linn. (some calcareous grains)
Bythinia tentaculata, Linn.
Helix hispida? Linn.
Zonites nitidula? Drap.
Limnæa palustris, Linn.
——— *truncatulus*? Linn.
Planorbis albus? Müll.
——— *spirorbis*, Linn.
Succinea putris, Linn.
Valvata piscinalis, Linn.

To this list we can now add, from specimens obtained during our recent visits, *Pisidium fontinale*, var. *Henslowianum*, *Helix rotundatus*, and *Valvata cristata*; also teeth of two genera of freshwater fish—*Esox* and *Leuciscus*.[2]

Mr. Thomas Belt subsequently tried to prove the interglacial age of the implement-bearing loams, laying special stress on the occurrence in the pit in Oakley Park of a small patch of chalky Boulder-clay overlying the loam.[3]

A year or two later Mr. H. B. Woodward and one of the writers of this paper visited Hoxne, and found that there was a little Boulder-clay in the position indicated by Mr. Belt. But the visit made in May of the present year showed the patch more clearly, and it proved to be merely the remains of some clay which had been brought to the pit at an early date—perhaps more than one hundred years ago—when the clay was first dug. This Boulder-clay distinctly rested in one place on the recent vegetable soil.

Numerous references to the implements from Hoxne, and several

[1] Prof. Prestwich informs us that the oak wood was not found by himself, but was obtained from one of the men, who stated that pieces occasionally occur in a very sound condition, like the specimen which he produced. The wood is evidently fossil, but the exact horizon from which it was obtained may have been wrongly observed.

[2] Determined by Mr. E. T. Newton.

[3] Quart. Journ. Sci., n.s. vol. vi. pp. 289-304.

other papers dealing theoretically with the question of the age of the deposit, will be found; but for a record of the facts it is still necessary to go to Professor Prestwich, whose carefully measured sections and clear descriptions of the beds will stand, however our views as to the connection of the Palæolithic deposits with the Glacial beds may change.

Thus far what the writers have seen is strongly in favour of Prof. Prestwich's contention, that the lacustrine deposits rest in a hollow in the Boulder-clay.

The reason for our taking up with this subject was that we had been working for some time at Pre-historic and Pleistocene botany. Looking through the account of the Hoxne deposit we observed that Prof. Prestwich had recorded the plants already mentioned, as either associated with or underlying the implement-bearing beds. We wished to obtain a more complete knowledge of this flora, and to ascertain, if possible, the climatic conditions under which Palæolithic man lived.

At first sight it looks as if the long list of mollusca, or the mammals, ought to settle this question; but they are all species of wide range, and for sensitiveness to climatic changes no class equals the plants.

We, therefore, visited Hoxne last May, and again in July, but found that the digging of the clay had stopped for the season, and that the deeper parts of the pit were full of water. However, there was a large heap of clay, belonging to bed *d*, which had been dug during the winter from one of these flooded pits. This clay showed the lithological character, and the wood, shells, and bilberry-like leaves mentioned by Prof. Prestwich. We took away some of the clay, and on carefully washing and examining the samples after our return to London, we arrived at the somewhat unexpected result that there was a considerable proportion of thoroughly Arctic species among the plants, including such distinctly northern forms as *Salix polaris* and *Betula nana*. The following is a complete list of the plants, as far as we have been able to determine them:—

List of Species Obtained.

Ranunculus aquatilis, L., Fruits.
R. sceleratus, L., Fruit.
R. repens, L., Fruit.
R. Flammula, L., Fruit.
Rubus Idæus, L., Stones.
Comarum palustre, L., Fruits.
Hippuris vulgaris, L., Fruits.
Œnanthe Phellandrium, Lam., Fruits.
Cornus sanguinea, L., one unusually large seed.
Bidens cernua, L., Two fruits.
Ceratophyllum demersum, L., Fruits.
Alnus glutinosa, Gaertn., Cones & Seeds.
Betula nana, L., Leaves.
Salix polaris, Wahlb., A stem, leaves and fruits.
S. myrsinites, L., Leaves and fruit.
Taxus baccata, L., Wood and a seed.
Pinus, sp, Bark.
Sparganium ramosum, L., A whole fruit, and one bitten in two.
Potamogeton pusillus, L., Fruit.
P. trichoides, Cham., Fruit.
P. rufescens, Schrad., Fruit.
P. pectinatus, L., Fruit.
P. crispus, L., Several fruits.
Scirpus lacustris, L., Fruit.
Sc. pauciflorus, Lightf., Fruit.
Eleocharis palustris, L., An imperfect nut.
Carex ampullacea, L., Fruits.
Chara, sp., One nucule.

Mosses.

Brachythecium rutabulum, Bruch. and Schimp.
Amblystegium fluitans, Mitt.
Hylocomnium squarrosum, Schimp.
Campylium stellatum, Mitt.
Acroceratium sarmentosum, Mitt.
A. cuspidatum, Mitt.
Philonotis fontana, Brid.
Webera albicans, Schimp.
Bryum pallens, Sw.
Mnium punctatum, L.

These mosses are all fragments of stems with the leaves attached, and often much decayed. We are indebted to Mr. Mitten for kindly identifying them.

A glance at the list of flowering plants shows that the flora with which we have to deal was an Arctic one, corresponding in some respects to that of Iceland. The presence of the two *Salices* and *Betula nana* is sufficient evidence of this, which is confirmed by the mosses, of which Mr. Mitten remarks that they look like a lot of bits drifted down in a mountain-stream. *Acroceratium sarmentosum* is especially noteworthy as being an Alpine moss, growing in the mountains of Killarney, Scotland, etc.

Salix myrsinites has not hitherto been recorded as a fossil plant. The foliage attributed to "bilberry" in Prof. Prestwich's paper was that of this species, which bears a resemblance to the leaves of a *Vaccinium* on cursory examination. *Cornus sanguinea* is represented by a single seed so large that we were for a long time dubious as to its belonging to this species, but it seems impossible to refer it to any other, and we must conclude it to be merely an unusually large form. The fruits referred to *Œnanthe Phellandrium* are exceptionally small ($\frac{1}{10}$ inch), but otherwise correspond exactly with our recent specimens.

As is usual in these deposits, there is a large proportion of aquatics, and plants which occur on the damp edges of streams and the banks of lakes, whence their seeds have drifted into the mud at the bottom, and nearly all are plants still occurring in high latitudes, but there are several species not truly Arctic, at least at the present day; these are *Taxus baccata*, *Sparganium ramosum*, *Cornus sanguinea*, and *Potamogeton trichoides*. *Bidens cernua* is not included in Hooker's distribution of Arctic plants (Trans. Linn. Soc. vol. xxiii. p. 251), but *B. tripartita* is. *B. cernua* however seems to go up north almost as far as *B. tripartita*, though it appears to be less common everywhere. On the other hand, we have *Salix polaris*, only occurring now in very high Arctic latitudes. This species we know from other deposits was much more widely distributed in Glacial and Postglacial times. It has been found in Prussia.

The flora thus suggests the approach of a warmer period following an Arctic one, so that the Arctic flora was not entirely gone by the time that the more temperate one had come.

III.—Further Observations on the Form of Vesuvius and Monte Somma.

By H. J. Johnston-Lavis, M.D., F.G.S., B.-ès-S.

In the year 1884 a paper of mine, entitled "The Geology of Monte Somma and Vesuvius," was published (Quart. Journ. Geol. Soc. vol. xl. pp. 35 to 119), in which I proposed a new explanation for the peculiarities in form of this volcano. An endeavour was made to show that the truncation of Monte Somma by the series of explosive eruptions, especially of *Phase VI.*, had occurred around an eruptive axis different from that which belonged to the period of vesuvian activity, by which the original Somma cone had been built up. Furthermore, a law was enunciated, which is applicable to a very large number of volcanoes, of which, even in Italy, the following examples may be taken in their order of perfection, viz. Roccamonfina, Mt. Vultura, Etna, Stromboli, Vulcano, and some of the Roman ones. The following are some of the words used: "There is very good reason to deny the concentricity of the great crater of the Atrio with the original cone of Monte Somma. If within a cone we scoop out an inverted conical hollow around an axis eccentric, but parallel, to that of the solid, we shall have the included space bounded by an annular ridge, not horizontal, but sloping down in the direction of the axis of excavation, and inclined proportionally more, the further the axis of excavation is removed from that of the solid.

"It is just with such a condition of things that we have to deal in the present instance. If we measure the distance of the modern eruptive axis (*i.e.* the centre of Vesuvius), from, say, the 650 metres contour-line on the northern slope of Somma, and compare it with that of the same line on the south, we shall find that this axis is between[1] 850 and 950 metres to the south of the centre of the contour-lines of the ancient Somma. In a regular cone, such as we suppose this ancient volcano to have been, the centre of the contour-line would be the eruptive axis of the mountain.

"From these facts we must conclude that although the eruptions that excavated the great crater of the Atrio, and subsequently piled up the cone of Vesuvius, occurred from the same axis, this was nearly a kilometre to the south of the ancient one, of the primary cone of Somma.

"It seems also that the modern axis is slightly displaced to the west of south; but from the obscured features of the ground the exact amount cannot be accurately measured, although it was hardly south-west, as thought by Prof. Phillips.

"This change in the position of the eruptive axis appears to be the most rational explanation of the great difference in height of nearly 500 metres, between the southern and northern ridge of Monte Somma."

I showed that at the same time the hypotheses given by earlier

[1] This is an error of calculation: it should be between 445 and 475.

writers were insufficient to explain the greater truncation of the Somma cone to the south.

Prof. Pasquale Franco last year published a paper, "Il Vesuvio ai tempi di Spartaco e di Strabone," Atti dell' Accad. Pontaniana, vol. xvii., in which my views are severely criticized, and a new hypothesis put forward to explain the lower truncation of Somma to the south.

My critic commences by accusing me of having neglected mentioning that Palmieri had pointed out that in pre-Plinian times the lower edge of Somma was to the south, and he overlooks the fact that this was so evident to any one who had devoted attention to the subject, that it would have been prolix to mention it again. What I really did was, taking such for granted, to give a rational explanation of the cause of it.

The next objection is raised against my supposition that the cone of Somma was a regular one before its truncation. There is no evidence whatever that it was otherwise, for the following reasons: 1st, It was built up by the constant and regular emission of lava, at any rate while a mantle of from 300 to 400 metres were added to its flanks, as evidenced by the great section of the Atrio, conditions which result in the construction of a fairly symmetrical cone obliterating old irregularities, examples of which we have in the Vesuvian cone itself, Etna, etc. 2nd, The plan of the base of the whole mountain was nearly circular (it is now being deformed and extended by the lavas and alluvions being directed more to its south, east and west sides).

I am then blamed for choosing the 650 contour-line to find the original axis of Somma, and my critic proceeds to try my method on that and eight other contour lines, on a section 40° N. of E. to 40° S. of W., which was not the line I chose, always with the result that the Vesuvian axis is found displaced 430 metres, the minimum displacement being 300 and the maximum 620. My reason for choosing the 650 contour-line was that it is the highest limit of the Atrio crater, or the Somma edge on the south, and as a ridge obviously less exposed to alteration in height than the slopes below, according to well-known mechanical principles of denudation, and the repose of material. The deposits of lava, etc., on this point cannot amount to many metres, whilst on the less inclined slopes below it is demonstrable the lava flows are much thicker, and the alluvial deposits very great indeed, as examination in the field will make more evident than speculation at home. My friend himself admits far greater accumulations on the southern slopes, whereas in the middle zone of the northern slopes of Somma there has been more removal than addition on the whole. This is made strikingly evident by his own table of calculated eccentricities for six contour-lines below the 650, which shows, with one exception, a continuous and progressive diminution in the apparent value of eccentricity, which the author in the third paragraph of page 11 shows a thorough appreciation of. But he immediately contradicts himself in the next statement that there is reason to believe that the denudation was much greater on

the south side than on the north, and doubts what compensation the modern lavas, etc., have given. On the north side, in pre-Plinian times, the upper parts of the mountain of Somma always collected the waters which at lower levels, where the inclination was still great, produced enormous erosion on the northern slopes, as observations in the field clearly demonstrate. But at the same time, after the great crater of the Atrio, after Phase VI., had been filled up, all the water falling on it would either sink in or escape over the lower or southern edge, and not being endowed with that momentum acquired in falling from steep slopes above, could denude little, and would rather soon deposit its rocky burden. Thus there is every evidence that even in pre-Plinian times nature was trying to obliterate that want of symmetry produced by the grand explosive eruption of Phase VI. and their predecessors.

The author then again states his opinion that the old cone of Somma was not a regular one, since he considers that denudation during many centuries of eccentric eruptions (here the author no doubt means those small outbursts with outflow of lava and formation of parasitic cones similar to the 1861 eruption) would have destroyed that regularity. I have already stated my facts for believing that the Somma cone was a regular one, and that so far as denudation goes, that agent of destruction may be entirely neglected, for in an active volcano of the kind under consideration, we should have a surface similar to that of the Vesuvian cone at present, that is, not susceptible of any important change from meteoric agencies. Falling rain immediately sinks into the porous lapilli, and scoriæ, its energy at the moment of impact being chiefly converted into heat. It is only years or centuries after a cone of this kind has become extinct, that vegetation commences to grow on the upper parts of the mountain, and so by rendering the surface less permeable and therefore fit to serve as a water collector. Then, the rain retained on the surface, and rushing down the slopes with considerable momentum, may commence to erode valleys. Nevertheless, the symmetry of a cone is not destroyed, for the valleys that score its sides are roughly equal in size, etc., and symmetrically arranged around it, like the surface between the ribs of a half-opened umbrella.

As to eccentric lava eruptions, the only way in which they modify the symmetry of the cone would be in raising parasitic cones upon its flanks; but surely, the author can hardly deem these worthy of consideration in the question now being considered. Would the numbers of cones and craterets on Etna in any way influence the formation of a crater of explosion?

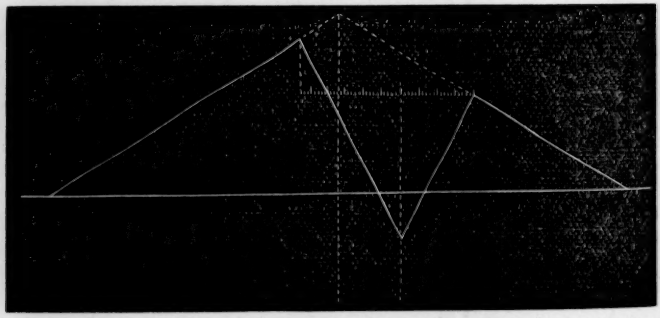
But to still more strongly confirm what I have asserted, we will choose a part of Monte Somma still uncovered by lavas, and apply the contour-line method. The locality I shall choose is the two strips of the mountain which constitute the Bosco Cognoli, very lately and only in part covered by lava, and which bears a few degrees S. of S.E. from the present axis. It is therefore evident that as this is at an angle of at least 40° with the line of displacement of the eruptive axis, the calculated results of eccentricity should be

much under what they would be in a direction N. and S., or still more W. of S., yet these are the results :—

Contour-line.		Distance of the two axes.	
675	metres.	= 400	metres.
650	,,	= 410	,,
600	,,	= 460	,,
550	,,	= 460	,,
500	,,	= 530	,,
450	,,	= 540	,,
400	,,	= 450	,,

If we have such an eccentricity indicated by observation at this point, there evidently must be far more in the azimuth of displacement. But there is still another geological point that makes our figures too low, and that is, that the post-Plinian mantle, and probably the Plinian also, is very thick at B. Cognoli, whereas erosion has been very active on the opposite side of the volcano.

My learned friend then, on geometrical grounds, calculates the proper position of the vertex of Somma, and finds that, adopting the 600 m. contour-line as the southern boundary of the Atrio crater edge, a point opposite and symmetrical would fall outside a vertical line dropped from the crest of Somma. This could hardly be otherwise, as I absolutely reject the 600 contour-line as being the edge of the Atrio crater for reasons I have already and am about to give. Now, strangely enough, when my critic makes use of the 650 metre contour-line, the symmetrical point falls within the vertical line dropped from the crest of Somma, and the author admits that "the theory finds nothing absurd in its application." This, I think, still further confirms me in having chosen the latter contour-line as being the most justifiable to represent the original edge of Somma.



Diagrammatic sketch-section of a cone truncated by a crater formed around an axis eccentric to the original cone.

We then have a description of the figure given (Le Pitture di Ercolano e Contorni IV. p. 343), which is undoubtedly the cone of Monte Somma truncated by the great crater of Atrio, the result of the great explosive eruptions of Phase II., around an eccentric axis. The author then quotes Virgil and other authors, who use words equivalent to the modern Italian "giogaja" or mountain-ridge, which no doubt was the appearance Somma had at that time as seen from Nola; for now, when we look at that mountain from the same

locality, Somma appears as a beautiful symmetrical cone, truncated by a horizontal serrated ridge (well explained by the word "giogaja").

The quotations from the other well-known authors agree quite as well with the geological evidence I have brought forward, as with the figure under consideration, or as these agree together, the one confirming the others. It should be remarked, however, that none of these authors were scientists, or gave any detailed description or references to the mountain.

We then have to deal with another geometrical argument, for the author points out that the plan of the Atrio crater is circular (the interruptions in its limits are so many and so irregular that *circular* is somewhat a far-fetched expression to describe its form), whereas in truncating a regular cone sensibly an ellipse would result. This is perfectly true when we deal with a cone whose slopes are straight, but those of a volcano are curved with a concavity towards the axis. In truncating such a cone, we should not obtain an ellipse, but an ovoid. In truth, in our present consideration, geometrical arguments are of secondary consideration, in comparison to the physical facts concerned. In fact, it is hardly just to assume in one argument that the cone of the old volcano was very far from symmetrical, and to suit another argument to consider it as not only symmetrical, but homogeneous, which system of employing different data is pursued throughout the whole of my critic's memoir. The central core of a volcano is far more dense and compact than the peripheral parts,—first, because it has been exposed to greater superincumbent pressure, and secondly to the intense heat of the neighbouring chimney, which has cemented the fragmentary constituents together into one solid compact mass, such as we see constituting the bottom of the great Atrio section of Monte Somma, whereas towards the periphery, we have simply thin beds of lava, loose scoriæ, ash, etc. It is just this central resistent nucleus which is the probable cause of the eccentricity of explosive eruptions, after long inactivity taking place at some distance from the old axis. When the explosive eruption does take place, it will excavate and erode the part opposite the nucleus with much greater ease. The consequence of this is, that the lower crater edge will be removed further away from the new eruptive axis, so that in plan, it may even appear more distant from that axis, than the upper edge of the crater. This extra destruction of the peripheral part will be greatest near the lowest edge or point most distant from the nuclear part of the volcano, and will diminish, as we approach that part, so that the tendency always is to form a circular and neither an elliptical nor an ovoid-shaped crater. But this is counterbalanced on the northern edge, by subsequent denudation, and crumbling in of the Somma crest. Which of these two influences have been greatest in modifying the original outlines of the mountain, it would be rash to speculate upon. Above all other proofs, however, of the modern eruptive axis being nearer the S. or S.W. slope of the mountain is that all eccentric lava eruptions below the 650 contour-line have taken place within the southern semicircle since those of Phase IV.

Before quitting this part of the subject, there are two observations to make. In the first place, my critic continually makes me say that the Atrio was formed by the explosive eruption known as the Plinian. Now, this is displeasing to me, since I look upon that eruption as of comparatively feeble type, and also because I have stated the direct converse. My words are (*op. cit.* p. 36), "The *eruptions* that excavated the great crater of the Atrio, and *subsequently* piled up the cone of Vesuvius," and I devote nearly 100 pages to describe these eruptions; and again (p. 37, first paragraph), "It (Braeislak's theory) presupposes only one paroxysmal eruption, as the cause of all this great cavity, *whereas a number did the work piecemeal.*" Again, a similar statement is made on p. 65, second paragraph, p. 68, fifth paragraph, and particular attention should be paid to p. 82, fourth paragraph, where I refer the great crater in large part to as far back as the explosive eruption of Phase VI. period 1.

I take this opportunity of mentioning an observation I have made since I wrote my paper, namely, that the slope of the Vesuvian cone is steeper on the N.E. than on the S.W., as if its axis were undergoing gradual displacement in that direction, that is to say, the reverse of what occurred in pre-Plinian and Plinian times. May not the chimney of the volcano not having a straight course, result in this eccentricity consequent upon its being gradually worn so by the constant transmission of fluids through it?

Having to the author's own satisfaction demolished my theory, he proceeds to replace it by one of his own which we will now examine. His theory is that the prevalent wet wind being the *Scirrocco*, or South wind, that impinging on the southern crater ridge has demolished it, leaving the northern intact, and quotes to support his statement the difference in the denudation going on upon the Kasia chain of Sikkim, where in a distance of 20 miles the difference of rainfall is as 1 to 8½. Surely the author would not compare an isolated peak with a high range of mountains. The distance between the two ridges of Somma is not more than four kilometres, yet, we are to believe that the one part of Somma for a height of 500 metres has been swept away, leaving the other portion intact. Moreover, the author fails to take into consideration that for any amount of rainfall to produce a denuding effect, it must be collected together on an impermeable surface, from which it must acquire momentum before it can exert appreciable erosive action. Another fact put forward to support the author's view is that one side of the tower of Notre Dame of Paris is much more weathered than the other, due to prevalent winds. The author would have done better had he been silent upon this, for in the one, we have the result of weathering due to frost, wetting and drying and dissolving the stone, and the other to true surface erosion. If we take the loss of a few millimetres from the surface of Notre Dame during some centuries of exposure of a comparatively soft stone, and then estimate how long a considerable ridge of lavas, scorias, etc., 500 metres high, would require to be denuded at the same rate, we would find that this

action must at least be continued somewhere back in early geological time, and would render any astronomer or physicist most impatient in hurrying geologists up for time. Lastly, where have all the resulting materials gone? for they would be sufficient to entirely change the south slopes of the mountain. Had my critic studied the field geology of that region near the coast, he might observe the pumices of Phase VI. covered only by a few metres of alluvial breccia.

Lastly, if Prof. Franco's explanation was feasible, it should be applicable to all the volcanoes in its neighbourhood. Now, Roccamonfina, which so strikingly resembles Vesuvius in size, shape, and many of its rocks, has the lower lip of its crater of explosion directed to the opposite points of the compass, to that of Monte Somma, but no one would dare assert the prevailing winds to differ at Roccamonfina.

Conclusions.—That the picture discussed by the author is a very fair representation of Somma truncated by an eccentric crater produced by the explosive eruptions of Phase VI.

That ancient writers' accounts correspond fairly well with this figure, and the result of geological investigations.

That the Plinian eruption took place together with its successors around the same axis, as the explosive eruptions of Phase VI.

I would remark that this is a general statement; it is highly probable that not one of the great eruptions were from *exactly the same geometrical* axis; but by saying the *same axis*, I understand approximatively the same for practical considerations. In fact, it is very doubtful if the axis is exactly fixed during the whole period of any one single eruption.

In fine, I am deeply indebted to my friend Prof. Franco for so patiently discussing the historical part of the subject, and for giving us such a rich classical and literary treat, and really hope he will take up some other similar knotty questions bearing on such an interesting geological region.

IV.—British Museum Catalogue of Fossil Reptilia, and Papers on the Enaliosaurians.

By R. Lydekker, B.A., F.G.S., etc.

IN writing Part I. of the British Museum Catalogue of Fossil Reptilia, in which a large number of forms are known solely by *disjecta membra*, I was fully prepared to find that many of my determinations, which are frequently provisional, would subsequently need correction. It is, moreover, highly probable that there are really more species represented in the collection than I have indicated, as in some cases, in my desire to avoid the introduction of new specific or generic names which could not be fully substantiated, I have provisionally included under generic or specific headings specimens which may prove to indicate distinct forms. I have lately had the advantage of going over a considerable part of the Dinosaurian collection with Prof. Marsh, who has pointed out to me several erroneous determinations, the most important of which I am

glad to take an early opportunity of correcting. I am also indebted to Dr. Baur for pointing out a less excusable error in regard to the serial position of *Geosaurus*.

At the same time I take the opportunity of adding some observations regarding my papers on the Ichthyopterygia and Sauropterygia published in the July and August numbers of this Magazine, which were written in the hope of inviting criticism of which advantage might be taken in the second part of the Museum Catalogue.

In the diagnosis of the Pythonomorpha, Prof. Cope has been followed; and I have omitted to notice that Prof. Marsh [1] has figured a sternum in one genus. Following Owen [2] and Pictet [3] *Geosaurus* is placed in the Pythonomorpha. Wagner has, however, pointed out its relationship to *Cricosaurus*. In the crushed vertebræ of the type one of the transverse processes has been mistaken for the neural spine; and the apparently procœlous character of some of the centra seems to be due entirely to the effects of pressure. The vertebræ, indeed, are truly Crocodilian; and it seems that the genus (with which *Cricosaurus* is probably identical) should form the type of a distinct subfamily of Crocodilia, characterized by the presence of a sclerotic ring, and the absence of a lateral vacuity in the mandible. This subfamily *Geosaurinæ* should be placed next the subfamily *Metriorhynchinæ* of the *Teleosauridæ*, since the skull of *Cricosaurus* is essentially of the type of that of *Metriorhynchus*; with which genus I had, indeed, proposed to identify it. From the similarity in the teeth it is possible that *Pristichampsa*, of the Lower Eocene, may prove to be a late survivor of the *Geosaurinæ*.

The vertebræ of *Bothriospondylus suffosus* appeared to me to resemble the figure of the vertebra of *Creosaurus*, but Prof. Marsh states that they undoubtedly belong to an immature member of the Sauropoda, which may be identical with one of the Kimeridgian species of *Ornithopsis*. The vertebra of *B. robustus* is probably also referable to the same suborder, and may belong to an immature *Cetiosaurus*.

The two calcanea provisionally referred on p. 225 to *Iguanodon* are also recognized by the same authority as Sauropodous. The teeth provisionally assigned by Sir R. Owen to *Hylæosaurus*, and entered on p. 185 under that heading, Prof. Marsh recognizes as undoubtedly Sauropodous, having some resemblance to those of *Diplodocus*. This would remove any bar to Sir R. Owen's identification of *Regnosaurus* with *Hylæosaurus*; but the former may equally well be identical with the later *Polacanthus*, although probably too large to belong to *Vectisaurus*, on the assumption that the latter belongs to the *Scelidosauridæ*. Assuming that these teeth are truly Sauropodous, the small size of the tooth referred by Phillips (and probably correctly) to *Cetiosaurus Oxoniensis* suggests that they may belong to the smaller *C. brevis*, which would then be proved to differ widely from *Ornithopsis* (? *Pelorosaurus*), which had large teeth.

[1] Amer. Journ. ser. 3, vol. xix. pl. i. (1880).

[2] Odontography, p. 263. It is pointed out that the vertebræ approximate to the Crocodilian type.

[3] Paléontologie, 2nd edition, p. 506.

It is not improbable that the mandibular ramus entered on p. 227 as a young Iguanodont may really indicate a smaller adult form allied to *Laosaurus* or *Camptonotus*, in which event the undetermined femur mentioned on p. 195 may perhaps belong to the same form. I am also inclining to the opinion which was suggested in the Catalogue, that some of the portions of pectoral and pelvic girdles entered under the head of *Iguanodon Bernissartensis* may indicate a second large species of Wealden Iguanodont.

I am further indebted to Prof. Marsh for pointing out that the name *Omosaurus* is preoccupied by Leidy (Proc. Ac. Nat. Sci. Phila. 1856, p. 256). Since, however, the form so designated is known only by the preliminary description, I do not intend to propose a new name; more especially since I think it not improbable that *Stegosaurus* is generically inseparable from *Omosaurus*, in which case the former name should be adopted.

Turning to the Enaliosaurians, Prof. Marsh informs me that *Baptanodon* shows no trace even of a dental groove, and it would therefore seem that Dr. Baur's suggestion as to the generic unity of this form with *Ophthalmosaurus* is not well founded.

In regard to *Plesiosaurus Oxoniensis* (*suprà*, p. 352), a visit to the Oxford Museum, where I have seen the whole of the type-specimens, has shown that the skeletons in Mr. Leeds' collection indicate a form so much superior in size to the type of that species, that I am inclined to think it will be safe for the present to retain for them the name of *P. eurymerus*, although I can see no structural difference in the vertebræ. Both the pectoral girdle and the limb-bones figured by Phillips under the former name are from a different locality from the vertebral column, and I now think are probably both referable to *P. plicatus*. This pectoral girdle when entire was of the type of that of the so-called *Elasmosaurus*. In these notes I have used the term *Plesiosaurus* in its wider sense. With regard to *P. philarchus*, which I was inclined to include in *Thaumatosaurus*, I have since seen reasons which have induced me to regard this form as indicating a new genus connecting *Thaumatosaurus* with *Pliosaurus*.

Finally, I must offer my apologies to Prof. Cope for the statement regarding *Elasmosaurus* (*suprà*, p. 356). In a separate copy in the Museum Library of the memoir to which I have alluded the figure of the skeleton is given in the reversed manner I have mentioned. This copy belongs, however, to an advance issue, of which, I am informed, the greater portion was suppressed, and in the serial itself the erroneous restoration and the accompanying letterpress have been amended.

V.—An Undescribed Carboniferous Fossil.

By Prof. T. Rupert Jones, F.R.S., and Dr. Hy. Woodward, F.R.S.

In the Museum of Practical Geology, London, is a remarkable specimen, marked D $\frac{3\,6}{2}$, which the late Mr. J. W. Salter referred to, in the 'Quart. Journ. Geol. Soc.' vol. xix. 1863, p. 92, as "a huge bivalve Crustacean," . . . "with a carapace 7 inches long," giving it the name "*Dithyrocaris pholadomya*." It is in a dark micaceous

sandstone, from the "Carboniferous Shales" (or Lower Limestone of the Carboniferous-Limestone series), of Berwick-upon-Tweed. In the "Catalogue of the Collection of Fossils in the M.P.G.," 1865, p. 116, it is referred to as "*Dithyrocaris pholadiformis*"; but whether or no this specific name was an alteration made by Mr. Salter himself is doubtful.

The specimen consists of two counterparts, one on each moiety of the split slab, showing impressions of the outside of one, and of a part of the inside of the other valve.

"Seven inches" was evidently not the whole length of this extraordinary bivalved specimen, for probably more than an inch has been broken off at one end. Its width (height) is not wholly seen, for one valve (lying uppermost), broken away from the other, is shifted upwards to some extent over the perhaps more perfect dorsal edge of the other valve, and thus has lost probably a quarter or half an inch in that dimension. See woodcut, Fig. 1; half

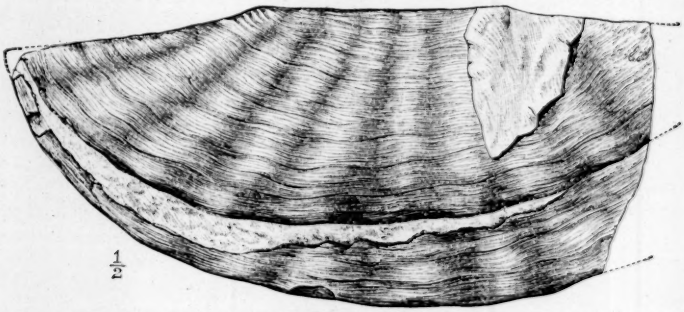


FIG. 1. *Salterella pholadiformis*, Lower Limestone Shales, Carboniferous Series, Berwick-on-Tweed.

natural size. As it lies in the stone, it has a boat-shaped outline, with an almost symmetrically elliptical curve on the lower border. The back, or upper edge, may have been either straight, or slightly convex, in its middle two-fourths; but it sloped downwards at a low angle towards the extremities on each of its terminal fourths. Hence, both in front and behind, at the junction of the two dorsal edges, there would be a slope, if the fossil were of a real bivalved form; or a narrow slit, if the valves lay open, or if it were originally buckler-shaped, but since folded up. Numerous concentric lines of growth run parallel with the free edges; they are irregular in their thicknesses, and are thrown into undulations by about twelve transverse, radiating furrows and ridges of the valves. These flexures are more strongly pronounced on that moiety of the valve which happens to be more perfect than the other.

The underlying valve or lateral moiety shows the lower part of the inner surface, below the outer or lower edge of the valve that lies uppermost. It shows longitudinal, concentric lines and transverse undulations, similar to those on the other (overlying) valve. Some matrix lies between the valves, as shown by a narrow seam of broken sandstone.

That this large and apparently once thin and tough bivalved specimen should have been referred to by Mr. Salter as belonging probably to the Phyllopoda would go far to induce us to support his view, if we knew of any analogous form among that group. As a bivalved Crustacean, however, the apparently equal ends of the valves, and their radiating furrows, are out of place or quite abnormal. If looked at as an Apudiform or buckler-shaped form, folded down the middle, the same objections occur. The probable slit at each end would serve for either case, though not quite fitting with the latter.

It is less difficult to find an analogue for this specimen among the Bivalved Molluscs. Thus *Siliqua radiata*, Linn., has a straight, feeble hinge-line, and concentric striæ, but radiating colour-lines instead of furrows. In *Soletellina violacea*, Lamarck, the hinge and umbo are stronger than in the foregoing; there are concentric striæ, and the radiating faint, colour-lines, are slightly raised. Both *Pholas* and *Pholadomya*, of course, have transverse ridges and furrows somewhat analogous to those of our fossil, but their other features do not coincide. *Clidophorus* has a straight hinge and radiating riblets; but the latter start from an umbo near one end; and the valves have a shape different from that of the specimen under notice.

Having thus noticed this interesting specimen, we must for the present leave its more definite generic relations indeterminate, hoping that fresh material may turn up through the energy of local observers and collectors whose attention is now again called to it. Although at present the position of this fossil must remain doubtful, yet, for the sake of convenience of reference and cataloguing, it may in future be known as *Salterina pholadiformis*, Salter, sp.

VI.—Additional Note on the Blue Hornblende of Mynydd Mawr.

By Alfred Harker, M.A., F.G.S.,
Fellow of St. John's College, Cambridge.

In the short description of the Mynydd Mawr rock given in the May Number of this Magazine (p. 221), I drew attention to a remarkable blue hornblende, which I was unable to refer to any known variety. In the character of its absorption and pleochroism it differed widely from both glaucophane and arfvedsonite, although allied to them in some of its properties, such as its extreme fusibility, splinters melting easily in the flame of a candle.

A paper by Dr. Sauer of Leipzig, which has just appeared,[1] throws considerable light on the subject, and makes it appear that we have here a new mineral of considerable interest. Among the rocks collected in the island of Socotra by the late Dr. Riebeck is a pink felspar-granite containing black crystals up to 5 mm. in length. This is the mineral which has been named *Riebeckite* in honour of the traveller, and which presents the closest resemblance to that occurring in the quartz-porphyry of Mynydd Mawr. It has been

[1] Zeitsch. d. Deutsch. geol. Gesellsch. vol. xl. p. 138, 1888.

examined optically by Prof. Rosenbusch, who writes as follows: "It was determined on more than 20 cleavage-flakes, that the axis of elasticity which makes an angle of only about 5° with c is a, not γ, as in the [other] amphiboles; its colour is dark blue; $b=\beta$, a rather less deep blue; γ, which is almost perpendicular to c,=green. Axial angle large. The characters are thus surprisingly like those of aegirine among the pyroxenes." That riebeckite holds chemically, as well as optically, the same place among the amphiboles as aegirine does among the pyroxenes, appears from Sauer's analysis. Compared with arfvedsonite, it shows more silica, much more ferric, and less ferrous oxide. Taking account of all its characters, there can be no reasonable doubt that the Mynydd Mawr mineral is riebeckite.

The blue tourmaline which I described, not without misgivings, as accompanying the blue hornblende, is, in all probability, the same mineral. Owing to the almost opaque nature of the sections, I was reduced to experimenting on the minute and impure crystals with a knife and a candle-flame; so perhaps the mistake was a pardonable one; the more so, as Professor Bonney, who has pointed it out to me, appears to have been himself deceived by the Socotra riebeckite, regarding it as a pseudomorph of tourmaline after hornblende.[1] His figure closely resembles the slides from Mynydd Mawr.

Besides the larger crystals of riebeckite, Sauer finds in the Socotra granite microlites of the same mineral, precisely similar to the colourless and pale-blue microlites already described in the rock of Mynydd Mawr. That these belong to riebeckite, rather than to tourmaline, is proved by the direction of maximum absorption being parallel, not perpendicular, to the long axis. Sauer regards them as due, at least in part, to the secondary alteration of the felspar. This last suggestion cannot be maintained in the case of the Welsh rock. Apart from chemical difficulties, the mode of occurrence of the microlites, and especially their fluxional disposition through the ground-mass, show them to be original constituents of the rock.

NOTICES OF MEMOIRS.

I.—British Association for the Advancement of Science.

Bath Meeting, September 5th to 12th, 1888.

List of Titles of Papers read before Section C. Geology.

Professor W. Boyd Dawkins, M.A., F.R.S., F.G.S., President.

The President's Address. (See infra p. 459.)

Horace B. Woodward.—Further Note on the Midford Sands. (p. 470.)

Horace B. Woodward.—The Relations of the Great Oolite to the Forest Marble and Fuller's Earth in the South-west of England. (See infra p. 467.)

Horace B. Woodward.—Note on the Portland Sands of Swindon, etc. (See infra p. 469.)

O. W. Jeffs.—On Geological Photography.

[1] Phil. Trans. vol. clxxiv. part i. p. 283, 1873.

Dr. C. Callaway.—Further Notes on the Origin of the Crystalline Schists of Malvern and Anglesey.

Dr. C. Callaway.—Sketch of the Geology of the Crystalline Axis of the Malvern Hills.

Dr. Persifor Frazer.—Archæan Characters of the rocks of the Nucleal Ranges of the Antilles.

Dr. Persifor Frazer.—Oligoclase and Quartz with curious Optical Properties.

Dr. H. W. Crosskey.—Report on Erratic Blocks.

Dr. H. W. Crosskey.—On a High Level Boulder-clay in the Midlands.

W. Whitaker.—On the Extension of the Bath Oolite under London, as shown by a deep boring at Streatham.

E. Wethered.—On the Lower Carboniferous Rocks of Gloucestershire.

Rev. H. H. Winwood.—On the Tytherington Section to be seen on Saturday's Excursion.

Handel Cossham, M.P.—The Northern Section of the Bristol Coal Field.

W. A. E. Ussher.—Some points of interest in the Geology of Somerset.

Prof. O. C. Marsh.—Comparison of the Principal Forms of Dinosauria of Europe and America.

H. F. Osborn.—The Evolution of the Mammalian Molar teeth to and from the tritubercular type.

Professor A. Gaudry.—On the great size of some Fossil Mammals.

Rev. Dr. A. Irving.—Note on the Relation of the Percentage of Carbonic Acid in the Atmosphere to the Life and Growth of Plants.

James Spencer.—On the Occurrence of a Boulder of Granitoid Gneiss or Gneissoid Granite in the Halifax Hard Bed Coal.

Chev. R. E. Reynolds.—The Caverns of Luray.

W. Topley.—Report on the rate of Erosion of the Sea Coasts of England and Wales.

Dr. Tempest Anderson.—The Volcanoes of the Two Sicilies. (p. 473.)

Dr. H. J. Johnston-Lavis.—Notes on the recent Volcanic Eruption in the Island of Vulcano.

Dr. H. J. Johnston-Lavis.—Report on the Volcanic Phenomena of Vesuvius.

Dr. H. J. Johnston-Lavis.—On the Conservation of Heat in Volcanic Chimneys.

Dr. H. J. Johnston-Lavis.—Note on a Mass containing Metallic Iron found on Vesuvius.

Dr. H. J. Johnston-Lavis.—Note on the Occurrence of Leucite at Etna.

Prof. E. W. Claypole.—Note on Some Recent Investigations into the Condition of the Interior of the Earth.

J. Logan Lobley.—On the Causes of Volcanic Action.

Professor John Milne.—Report on the Volcanic Phenomena of Japan.

O. H. Howarth.—On the recent Volcanic Structure of the Azorean Archipelago. (See infra p. 472.)

Professor G. A. Lebour.—Report of the Earth-Tremor Committee.

W. A. E. Ussher.—The Watcombe Terra-Cotta Clay.

A. Bell.—Report on the "Manure Gravels" of Wexford.

T. W. Shore.—Beds exposed in the Southampton New Dock Excavation.

Clement Reid and H. N. Ridley.—Fossil Arctic Plants from the Lacustrine Deposit at Hoxne. (Printed in full, see supra p. 441.)

G. W. Lamplugh.—Report on an Ancient Sea Beach near Bridlington.

Professor H. G. Seeley.—On the Origin of Oolitic Structure in Limestone Rock.

Professor F. Bassani.—Notes of some Researches on the Fossil Fishes of Chiavòn, Vicentino.

Professor T. Rupert Jones.—Report upon the Fossil Phyllopoda of the Palæozoic Rocks.

Professor W. C. Williamson.—Report on the Flora of the Carboniferous Rocks of Lancashire and West Yorkshire.

Professor H. G. Seeley.—On an *Ichthyosaurus* from Mombasa; with observations on the Vertebral Characters of the Genus.

A. Smith Woodward.—A comparison of the Cretaceous Fish-fauna of Mount Lebanon with that of the English Chalk. (See infra p. 471.)

A. Smith Woodward.—On *Bucklandium diluvii*, König, a Siluroid Fish from the London Clay of Sheppey. (See infra p. 471.)

Rev. Dr. A. Irving.—On the Origin of Graphite in the Archæan Rocks, with a review of the alleged evidence of Life on the Earth in Archæan Time.

Rev. G. F. Whidborne.—On some Devonian Cephalopods and Gasteropods.

Rev. G. F. Whidborne.—On some Devonian Crustaceans.

Rev. G. F. Whidborne.—On some Fossils of the Limestones of South Devon.

T. Sterry Hunt.—Mineralogical Evolution.

Professor J. F. Blake.—Report upon the Microscopic Structure of the Older Rocks of Anglesey.

Dr. C. Ricketts.—On a Probable Cause of Contortions of Strata.

J. Joly.—On the Temperature at which Beryl is Decolorized.

J. Joly.—On the Occurrence of Iolite in the Granite of Co. Dublin.

W. W. Watts.—An Igneous Succession in Shropshire.

C. E. De Rance.—Report on the Circulation of Underground Waters in the Permeable Formations of England.

W. H. Dalton.—A List of Works referring to British Mineral and Thermal Waters.

TITLES OF PAPERS READ BEFORE SECTION D. (BIOLOGY) BEARING UPON GEOLOGY.

Professor O. C. Marsh.—Restoration of *Brontops robustus*, from the Miocene of America.

Dr. S. J. Hickson and G. C. Bourne.—Discussion on Coral-Reefs.

Dr. H. Gadow.—The Nature of the Geological terrain as an important factor in the Geographical Distribution of Animals.

C. A. Barber.—On *Pachytheca*, a Silurian Alga of doubtful affinities.

II.—Address to the Geological Section of the British Association, Bath, 1888. By W. Boyd Dawkins, M.A., F.R.S., F.G.S., F.S.A., Professor of Geology and Palæontology in Owens College, President of the Section.

IN taking the chair occupied twenty-four years ago in this place by my honoured master, Professor Phillips, I have been much perplexed as to the most fitting lines on which to mould my Address. It was open to me to deal with the contributions to our knowledge since our last meeting in Manchester in such a manner as to place before you an outline of our progress during the last twelve months. But this task, difficult in itself, is rendered still more so by the special circumstances of this meeting, attended, as it is, by so large a number of distinguished geologists, assembled from nearly every part of the world for the purposes of the Geological Congress. It would be presumptuous of me, in the presence of so many specialists, to attempt to summarize and co-ordinate their work. Indeed, we stand too near to it to be able to see the true proportions of the various parts. I will merely take this opportunity of offering to our visitors, in the name of this section and of English geologists in general, a hearty welcome to our shores, feeling that not only will our science be benefited enormously by the simplification of geological nomenclature, but that we ourselves shall derive great advantage by a closer personal contact with them than we have enjoyed hitherto.

Our science has made great strides during the last twenty-four years, and she has profited much from the great development of her sisters. The microscopic analysis of the rocks has opened out a new field of research, in which physics and chemistry are in friendly rivalry, and in which fascinating discoveries are being made almost day by day as to metamorphism, and the crushing and shearing forces brought to bear upon the cooling and contracting crust while the earth was young. The deep-sea explorations have revealed the structure and the deposits of the ocean abysses, and the depths supposed to be without life, like the fabled deserts in the interior of Africa, are now known to teem with varied forms glowing with the richest colours. From a comparison of these deposits with the stratified rocks, we may conclude that the latter are marginal, and deposited in depths not greater than 1000 fathoms, or the shore end of the Globigerina ooze, and most of them at a very much less depth, and that consequently there is no proof in the geological record of the ocean depths having ever been in any other than their present places.

In North America the geological survey of the Western States has brought to light an almost unbroken series of animal remains, ranging from the Eocene down to the Pleistocene age. In these we find the missing links in the pedigree of the Horse, and sufficient evidence of transitional forms to cause Professor Flower to restore to its place in classification the order Ungulata of Cuvier. These may be expected to occupy the energies of our kinsmen on the other side of the Atlantic for many years, and to yield further proof of the truth of the doctrine of Evolution. The use of this word reminds me how

much we have grown since 1864, when evolution was under discussion, and when biological, physical, and geological laboratories could scarcely be said to have existed in this country. Truly may the scientific youth of to-day make the boast

'Ημεῖς μὲν πατέρων μέγ' ἀμείνονες εὐχόμεθ' εἶναι—

"We are much better off than our fathers were," while we, the fathers, have the poor consolation of knowing that when they are fathers, their children will say the same of them. There is reason to suppose that our science will advance more swiftly in the future than it has in the past, because it has more delicate and precise methods of research than it ever had before, and because its votaries are more numerous than they ever were.

In 1864 the attention of geologists was mainly given to the investigations of the later stages of the Tertiary period. The bent of my pursuits inclines me to revert to this portion of geological inquiry, and to discuss certain points which have arisen during the last few years in connection with the classificatory value of fossils, and the mode in which they may be best used for the co-ordination of strata in various parts of the world.

The principle of homotaxy, first clearly defined by Professor Huxley, has been fully accepted as a guiding principle in place of synchronism or contemporaneity, and the fact of certain groups of plants and animals succeeding one another in a definite order, in countries remote from each other, is no longer taken to imply that each was living in the various regions at the same time, but rather, unless there be evidence to the contrary, that they were not. While, however, there is a universal agreement on this point among geologists, the classificatory value of the various divisions of the vegetable and animal kingdoms is still under discussion, and, as has been very well put by my predecessor in this chair at Montreal, sometimes the evidence of one class of organic remains points in one direction, while the evidence of another class points in another and wholly different direction as to the geological horizon of the same rocks. The Flora, put into the witness-box by the botanist, says one thing, while the Mollusca or the Vertebrata say another thing in the hands of their respective counsel. There seems to be a tacit assumption that the various divisions of the organic world present the same amount of variation in the rocks, and that consequently the evidence of every part of it is of equal value.

It will not be unprofitable to devote a few minutes to this question, premising that each case must be decided on its own merits, without prejudice, and that the whole of the evidence of the flora and fauna must be considered. We will take the flora first.

The cryptogamic flora of the later Primary rocks shows but slight evidence of change. The forests of Britain and of Europe generally, and of North America, were composed practically of the same elements—Sigillaria, Calamites, and Conifers allied to the Ginkho—throughout the whole of the Carboniferous (16,336 feet in thickness in Lancashire and Yorkshire) and Devonian rocks, and do not present greater differences than those which are to be seen in the existing

forests of France and Germany. They evidently were continuous both in space and time, from their beginning in the Upper Silurian to their decay and ultimate disappearance in the Permian age. This disappearance was probably due to geographical and climatic changes, following the altered relations of land to sea at the close of the Carboniferous age, by which Secondary plants, such as *Voltzia* and *Walchia*, were able to find their way by migration from an area hitherto isolated. The Devonian formation is mapped off from the Carboniferous, and this from the Permian, but to a slight degree by the flora, and nearly altogether by the fauna. While the fauna exhibits great and important changes, the flora remained on the whole the same.

The forests of the Secondary period, consisting of various Conifers and Cycads, also present slight differences as they are traced upwards through the Triassic and Jurassic rocks, while remarkable and striking changes took place in the fauna, which mark the division of the formations into smaller groups. As the evidence stands at present, the Cycads of the Lias do not differ in any important character from those of the Oolites or the Wealden, and the *Salisburia* in Yorkshire in the Liassic age is very similar to that of the Island of Mull in the Early Tertiary, and to that (*Salisburia adiantifolia*) now living in the open air in Kew Gardens.

Nor do we find evidence of greater variation in the dicotyledonous forests, from their first appearance in the Cenomanian stage of the Cretaceous rocks of Europe and America, through the whole of the Tertiary period down to the present time. In North America the flora of the Dakota series so closely resembles the Miocene of Switzerland that Dr. Heer has no hesitation in assigning it in the first instance to the Miocene age. It consists of more than one hundred species, of which about one-half are closely allied to those now living in the forests of North America—Sassafras, Tulip, Plane, Willow, Oak, Poplar, Maple, Beech, together with *Sequoia*, the ancestor of the giant Redwood of California. The first Palms also appear in both continents at this place in the Geological record.

In the Tertiary period there is an unbroken sequence in the floras, as Mr. Starkie Gardner has proved, when they are traced over many latitudes, and most of the types still survive at the present day, but slightly altered. If, however, Tertiary floras of different ages are met with in one area, considerable differences are to be seen, due to progressive alterations in the climate and altered distribution of the land. As the temperature of the Northern Hemisphere became lowered, the tropical forests were pushed nearer and nearer to the Equator, and were replaced by plants of colder habit from the northern regions, until ultimately, in the Pleistocene age, the Arctic plants were pushed far to the south of their present habitat. In consequence of this Mr. Gardner concludes that "it is useless to seek in the Arctic regions for Eocene floras as we know them in our latitudes, for during the Tertiary Period the climatic conditions of the earth did not permit their growth there. Arctic fossil floras of temperate and therefore Miocene aspect are in all probability

of Eocene age, and what has been recognized in them as a newer or Miocene facies is due to their having been first studied in Europe in latitudes which only became fitted for them in Miocene times. When stratigraphical evidence is absent or inconclusive, this unexpected persistence of plant types or species throughout the Tertiaries should be remembered, and the degrees of latitude in which they are found should be well considered before conclusions are published respecting their relative age."

This view is consistent with that held by the leaders in botany, Hooker, Dyer, Saporta, Dawson, and Asa Gray—whose recent loss we so deeply deplore—that the North Pole region is the centre of dispersal, from which the Dicotyledons spread over the Northern Hemisphere. If it be true—and I, for one, am prepared to accept it—it will follow that for the co-ordination of the subdivisions of the Tertiary strata in various parts of the world, the plants are uncertain guides, as they have been shown to be in the case of the Primary and Secondary rocks. In all cases where there is a clash of evidence, such as in the Laramie lignites, in which a Tertiary flora is associated with a Cretaceous fauna, the verdict in my opinion must go to the fauna. They are probably of the same geological age as the deposit at Aix-la-Chapelle.

I would remark further, before we leave the floras behind us, that the migration of new forms of plants into Europe and America took place before the arrival of the higher types in the fauna, after the break-up of the land at the close of the Carboniferous period, after the great change in geography at the close of the Neocomian. The Secondary Plants preceded the Secondary Vertebrates by the length of time necessary for the deposit of the Permian rocks, and the Tertiary Plants preceded the Tertiary Vertebrates by the whole period of the Upper Cretaceous.

Let us now turn to the fauna.

Professor Huxley, in one of his many addresses which have left their mark upon our science, has called attention to the persistence of types revealed by the study of Palæontology, or, to put it in other words, to the singularly little change which the ordinal groups of life have undergone since the appearance of life on the earth. The species, genera, and families present an almost endless series of changes, but the existing orders are for the most part sufficiently wide, and include the vast series of fossils without the necessity of framing new divisions for their reception. The number of these extinct orders is not equally distributed through the animal kingdom. Taking the total number of orders at 108, the number of extinct orders in the Invertebrata amounts only to 6 out of 88, or about seven per cent., while in the Vertebrates it is not less than 12 out of 40, or 30 per cent. These figures imply that the amount of ordinal change in the fossil Vertebrates stands to that in the Invertebrata in the ratio of 30 to 7. This disproportion becomes still more marked when we take into account that the former has less time for variation than the latter, which had the start by the Cambrian and Ordovician periods. It follows also that as a whole they have changed faster.

The distribution of the extinct orders in the animal kingdom, taken along with their distribution in the rocks, proves further that some types have varied more than others, and at various places in the geological record. In the Protozoa, Porifera, and Vermes there are no extinct orders; among the Cœlenterates one, the Rugosa; in the Echinodermata three, Cystideans, Edriasterida, and Blastoidea; in the Arthropoda two, the Trilobita and Eurypterida. All these, with the solitary exception of the obscure order Rugosa, are found only in the Primary rocks. Among the Pisces there are none; in the Amphibia one, the Labyrinthodonts ranging from the Carboniferous to the Triassic age. Among the Reptilia there are at least six of Secondary age, Plesiosauria, Ichthyosauria, Dicynodontia, Pterosauria, Theriodontia, Dinosauria; in the Aves two, the Saururæ and Odontornithes, also Secondary. In the Mammalia the Amblypoda, Tillodontia, Condylarthra, and Toxodontia represent the extinct orders—the first three Early Tertiary, and the last Pleistocene. It is clear, therefore, that while the maximum amount of ordinal variation is presented by the Secondary Reptilia and Aves, all the extinct orders in the Tertiary are Mammalian.

If we turn from the extinct orders to the extinct species, it will also be found that the maximum amount of variation is presented by the plants, and all the animals, excepting the Mammalia, in the Primary and Secondary periods.

The general impression left upon my mind by these facts is that, while all the rest of the animal kingdom had ceased to present important modifications at the close of the Secondary period, the Mammalia, which presented no great changes in the Secondary rocks, were, to quote a happy phrase of Professor Gaudry, "en pleine évolution" in the Tertiary age. And when, further, the singular perfection of the record allows us to trace the successive and gradual modifications of the Mammalian types from the Eocene to the close of the Pleistocene Age, it is obvious that they can be used to mark subdivisions of the Tertiary Period, in the same way as the reigns of kings are used to mark periods in human history. In my opinion they mark the geological horizon with greater precision than the remains of the lower members of the animal kingdom, and in cases such as that of Pikermi, where typical Miocene forms, such as Dinotheria, are found in a stratum above an assemblage of marine shells of Pliocene age, it seems to me that the Mammalia are of greater value in classification than the Mollusca, some of the species of which have been living from the Eocene down to the present day.

Yet another important principle must be noted. The fossils are to be viewed in relation to those forms now living in their respective geographical regions. The depths of the ocean have been where they are now since the earliest geological times, although continual geographical changes have been going on at their margins. In other words, geographical provinces must have existed even in the earlier geological periods, although there is reason to believe that they did not differ so much from each other as at the present day. It follows from this that the only just standard for comparison in

dealing with the fossils, and especially of the later rocks, is that which is offered by the fauna and flora of the geographical province in which they are found. The non-recognition of this principle has led to serious confusion. The fauna, for example, of the Upper Sivalik Formation has been very generally viewed from the European standpoint, and placed in the Miocene, while, judged by the standpoint of India, it is really Pliocene. A similar confusion has followed from taking the Miocene flora of Switzerland as a standard for the Tertiary flora of the whole of the Northern Hemisphere.

It now remains for us to see how these principles may be applied to the co-ordination of Tertiary strata in various parts of the world. In 1880 I proposed a classification of the European Tertiaries, in which, apart from the special characteristic fossils of each group, stress was laid on the gradual approximation of various groups to the living Mammalia. The definitions are the following:—

Divisions.	Characteristics.
1. Eocene, or that in which the higher Mammals (Eutheria) now on the earth were represented by allied forms belonging to existing orders and families. Oligocene.	Extinct orders. Living orders and families. No living genera.
2. Miocene, in which the alliance between fossil and living Mammals is closer than before.	Living genera. No living species.
3. Pliocene, in which living species of Mammals appear.	Living species few. Extinct species predominant.
4. Pleistocene, in which living species of Mammals preponderate.	Living species abundant. Extinct species present. Man present.
5. Prehistoric, or that period outside history in which Man has multiplied exceedingly on the earth and introduced the domestic animals.	Man abundant. Domestic animals present. Wild Mammals in retreat. One extinct Mammal.
6. Historic, in which the events are recorded in history.	Records.

These definitions are of more than European significance. The researches of Leidy, Marsh and Cope prove that they apply equally to the Tertiary strata of North America. The Wasatch Bridger and Uinta strata contain representatives of the orders Cheiroptera and Insectivora, the suborders Artio- and Perissodactyla, and the families Vespertilionidæ and Tapiridæ; but no living genera.[1] The Mammalia are obviously in the same stage of evolution as in the Eocenes of Europe, although there are but few genera, and no species common to the two.

[1] The genus *Vesperugo* has not been satisfactorily determined. Cope, Report of Geological Survey of the Territories, Tertiary Vertebrata, vol. i. 1884.

The White River and Loup Fork Groups present us with the living genera *Sciurus*, *Castor*, *Hystrix*, *Rhinoceros*, *Dicotyles*, and others; but no living species, as is the case with the Miocenes of Europe. In the Pliocenes of Oregon the first living species appear, such as the Beaver, the Prairie Wolf, and two Rodents (*Thomomys clusius* and *T. talpoides*), while in the Pleistocene river deposits and caves, from Eschscholtz Bay in the north to the Gulf of Mexico in the south, there is the same grouping of living with extinct species as in Europe, and the same evidence in the glaciated regions that the Mammalia occupied the land after the retreat of the ice.

If we analyze the rich and abundant fauna yielded by the caves and river deposits both of South America and of Australia, it will be seen that the Pleistocene group in each is marked by the presence of numerous living species in each, the first being remarkable for their gigantic extinct Edentata, and the second for their equally gigantic extinct Marsupials.

The admirable work of Mr. Lydekker allows us also to see how these definitions apply to the fossil Mammalia of India. The Miocene fauna of the Lower Sivaliks has yielded the living genera *Rhinoceros* and *Manis*, and no living species.

The fauna of the Upper Sivaliks, although it has only been shown, and that with some doubt, to contain one living Mammal, the Nilghai (*Boselaphus tragocamelus*), stands in the same relation to that of the Oriental region, as that of the Pliocenes of Europe to that of the Palæarctic region, and is therefore Pliocene. And lastly, the Narbada formation presents us with the first traces of Palæolithic Man in India in association with the living one-horned Rhinoceros, the Nilghai, the Indian Buffalo, two extinct Hippopotami, Elephants, and others, and is Pleistocene.

It may be objected to the Prehistoric and Historic divisions of the Tertiary Period that neither the one nor the other properly fall within the domain of Geology. It will, however, be found that in tracing the fauna and flora from the Eocene downwards to the present day there is no break which renders it possible to stop short at the close of the Pleistocene. The living plants and animals were in existence in the Pleistocene age in every part of the world which has been investigated. The European Mollusca were in Europe in the Pliocene age. The only difference between the Pleistocene fauna, on the one hand, and the Prehistoric, on the other, consists in the extinction of certain of the Mammalia at the close of the Pleistocene age in the Old and New Worlds, and in Australia. The Prehistoric fauna in Europe is also characterized by the introduction of the ancestors of the present domestic animals, some of which, such as the Celtic shorthorn (*Bos longifrons*), Sheep, Goat, and domestic Hog, reverted to a feral condition, and have left their remains in caves, alluvia, and peat-bogs over the whole of the British Isles and the Continent. These remains, along with those of Man in the Neolithic, Bronze, and Iron stages of culture, mark off the Prehistoric from the Pleistocene strata. There is surely no reason why a cave used by Palæolithic Man should be handed over to the geologist,

while that used by men in the Prehistoric age should be taken out of his province, or why he should be asked to study the lower strata only in a given section, and leave the upper to be dealt with by the archæologist. In these cases the ground is common to geology and archæology, and the same things, if they are looked at from the standpoint of the History of the Earth, belong to the first, and, if from the standpoint of the history of Man, to the second.

If, however, there be no break of continuity in the series of events from the Pleistocene to the Prehistoric ages, still less is there in those which connect the Prehistoric with the period embraced by history. The Historic date of a cave or of a bed of alluvium is as clearly indicated by the occurrence of a coin as the geological position of a stratum is defined by an appeal to a characteristic fossil. The gradual unfolding of the present order of things from what went before compels me to recognize the fact that the Tertiary Period extends down to the present day. The Historic period is being recorded in the strata now being formed, exactly in the same way as the other divisions of the Tertiary have left their mark in the crust of the earth, and history is incomplete without an appeal to the geological record. In the masterly outline of the description of Roman civilization in Britain the historian of the English Conquest was obliged to use the evidence, obtained from the upper strata, in caves which had been used by refugees from the cities and villas; and among the materials for the future history of this city there are, to my mind, none more striking than the proof, offered by the silt in the great Roman bath, that the resort of crowds had become so utterly desolate and lonely in the ages following the English Conquest as to allow of the nesting of the Wild Duck.

I turn now to the place of Man in the geological record, a question which has advanced but little since the year 1864. Then, as now, his relation to the Glacial strata in Britain was in dispute. It must be confessed that the question is still without a satisfactory answer, and that it may well be put to "a suspense account." We may, however, console ourselves with the reflection that the River-drift Man appears in the Pleistocene strata of England, France, Spain, Italy, Greece, Algiers, Egypt, Palestine, and India along with Pleistocene animals, some of which were pre-Glacial in Britain. He is also proved to have been post-Glacial in Britain, and was probably living in happy, sunny, southern regions, where there was no ice, and therefore no Glacial period, throughout the Pleistocene age.

It may further be remarked that Man appears in the geological record where he might be expected to appear. In the Eocene the Primates were represented by various Lemuroids (*Adapis*, *Necrolemur*, and others) in the Old and New Worlds. In the Miocene the Simiadæ (*Dryopithecus*, *Pliopithecus*, *Oreopithecus*) appear in Europe, while Man himself appears, along with the living species of Mammalia, in the Pleistocene age, both in Europe and in India.

The question of the antiquity of Man is inseparably connected with the further question: "Is it possible to measure the lapse of geological time in years?" Various attempts have been made, and

all, as it seems to me, have ended in failure. Till we know the rate of causation in the past, and until we can be sure that it has been invariable and uninterrupted, I cannot see anything but failure in the future. Neither the rate of the erosion of the land by subaërial agencies, nor its destruction by oceanic currents, nor the rate of the deposit of stalagmite or of the movement of glaciers, have as yet given us anything at all approaching a satisfactory date. We only have a sequence of events recorded in the rocks, with intervals the length of which we cannot measure. We do not know the exact duration of any one geological event. Till we know both, it is surely impossible to fix a date, in terms of years, either for the first appearance of Man or for any event outside the written record. We may draw cheques upon "The Bank of Force" as well as on "The Bank of Time."

Two of my predecessors in this chair, Dr. Woodward and Professor Judd, have dealt with the position of our science in relation to Biology and Mineralogy. Professor Phillips in 1864 pointed out that the later ages in Geology and the earlier ages of mankind were fairly united together in one large field of inquiry. In these remarks I have set myself the task of examining that side of our science which looks towards History. My conception of the aim and results of Geology is, that it should present a universal history of the various phases through which the earth and its inhabitants have passed in the various periods, until ultimately the story of the earth, and how it came to be what it is, is merged in the story of Man and his works in the written records. Whatever the future of Geology may be, it certainly does not seem likely to suffer in the struggle for existence in the scientific renascence of the nineteenth century.

III.—The Relations of the Great Oolite to the Forest Marble and Fuller's-earth in the South-west of England. By Horace B. Woodward, F.G.S., of the Geological Survey of England and Wales.

[Communicated by permission of the Director-General of the Geological Survey.]

THE southerly attenuation of the Great Oolite, and its absence in Dorsetshire, have been generally attributed to lateral changes in the strata—it being considered that the Great Oolite is mainly replaced by Forest Marble (which has been stated to increase in thickness southwards), and perhaps in part by the Fuller's-earth.

In Gloucestershire the Great Oolite and Forest Marble are so interblended that there is no real line of demarcation. At Bradford-on-Avon this is not the case: the surface of the Great Oolite, with its clusters of *Apiocrinus*, indicates a pause in deposition, and we have locally a good line of division between this formation and the Bradford Clay, which is a subordinate portion of the Forest Marble. Southwards the Bradford Clay horizon extends to the Dorsetshire coast, but the Great Oolite is no longer found, and we see no evidence of the Crinoid growth *in situ*. The estimated thickness of the Forest Marble in Dorsetshire has been much exaggerated, and the evidence

furnished by the persistence of the Bradford Clay is opposed to the view that the Great Oolite is replaced in any way by the Forest Marble.

In Oxfordshire and Gloucestershire the Great Oolite and the Stonesfield Slate merge downwards into the Fuller's-earth with no marked stratigraphical division, and this is the case as far as Lansdown, near Bath. Northwards the Fuller's-earth is much attenuated, and near Chipping Norton it rests on a higher stage of the Inferior Oolite than we find in the Cotteswold Hills, as if in the former area the conditions attending the deposition of Inferior Oolite lingered longer. Rarely do we find any interblending of Inferior Oolite and Fuller's-earth; indeed, we sometimes find indications of local pauses in deposition, marked by annelide burrows, etc. So that on stratigraphical grounds the Fuller's-earth is more intimately connected with the Great Oolite than with the Inferior Oolite.

In Dorsetshire the Fuller's-earth series attains its greatest development in this country, and is separable into Upper and Lower clayey divisions, with an intermediate bed of Fuller's-earth Rock. These divisions may be traced northwards to Lansdown and Slaughterford, near Bath, where the Fuller's-earth Rock is present in an attenuated form, and where the Upper Fuller's-earth merges into the base of the Great Oolite.

It is therefore clear that the mass of the Great Oolite is not represented in the Fuller's-earth series of Dorsetshire, although its lower beds may be partially replaced by the Upper Fuller's-earth. The mass of the Great Oolite, therefore, either wedges out abruptly south of Bradford-on-Avon, or has been to some extent denuded. On the whole, it appears probable that the Great Oolite has been denuded—the erosion being local and contemporaneous so far as the Great Oolite series is concerned. The structure of the Forest Marble, with its clay-galls, its current-bedded limestones made up of broken shells and oolitic grains (the latter sometimes in a sandy matrix), favours the notion that it may have been largely derived from previous accumulations; and this opinion was suggested by Dr. Sorby from a microscopical study of some of the beds.

The organic remains of the Fuller's-earth include many species common to the Inferior Oolite and many common to the Great Oolite. Of seventy-two species, obtained during the course of the Geological Survey, fifty-eight are known also in the Great Oolite and forty-two in the Inferior Oolite, a number being common to the two formations. The palæontological evidence therefore coincides with the stratigraphical, that the Fuller's-earth on the whole is more intimately connected with the Great Oolite than with the Inferior Oolite. For convenience of classification it should therefore be placed with the Great Oolite series.

IV.—Note on the Portland Sands of Swindon and Elsewhere.

By Horace B. Woodward, F.G.S., of the Geological Survey of England and Wales.

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ATTENTION was drawn to some fresh sections at Swindon, and these confirmed the sequence made out by Prof. J. F. Blake from somewhat scattered data. The sandy beds that yield the Swindon Stone were originally grouped as "Portland Sands," but they clearly belong to the Portland Stone division, as pointed out by Mr. Blake. The basement-bed here and at Aylesbury consists of a conglomeratic band containing lydites, a few quartz pebbles, and some derived fossils. The true Portland Sands occur below, and are about 60 feet thick. The sequence is as follows:—

		Feet.
Portland Stone, with lydite bed at base and in upper part of clay beneath.		
Portland Sands.	3. Blue and brown clay	19
	2. Sandy calcareous rock. Oyster-bed with small acuminate oyster	8
	1. Greenish and yellowish sands with huge concretionary masses of calcareous sandstone. The sands merge downwards into	30 to 40
Kimeridge Clay.		

Comparing the sequence with that at Aylesbury, worked out by Mr. Hudleston, we find the Portland Stone with lydite bed at base, resting on the Hartwell Clay. This clay, like the Blue and Brown clay (No. 3) at Swindon, was originally taken to be Kimeridge Clay, but the former has been shown to be on the horizon of the Middle Portlandian of French geologists, and there is no doubt, on stratigraphical and palæontological grounds, that the clays of Swindon and Hartwell are on the same approximate horizon, and that both belong to the Portland Sands. We have not clear evidence of the sequence beneath the Hartwell Clay at Aylesbury; but a deep well at Stone, in that neighbourhood, showed the presence beneath the Portland Stone of Blue clay, Limestone, Dark sand, and then Blue clay again—this last-named bed being, no doubt, the true Kimeridge Clay, although detailed measurements are wanting.

Doubtless there is some inconvenience in a term like Portland Sands, when it includes prominent beds of clay like those of Swindon and Hartwell, and when the Portland Stone of Swindon is so largely represented by sand. We might employ the terms Upper and Lower Portlandian, were it not that on the Continent a threefold division has been adopted, and the Lower Portlandian embraces beds that in this country cannot be separated from the Kimeridge Clay. The Middle Portlandian, as before mentioned, represents our Portland Sands and Hartwell Clay; and Professor Blake has applied the term Bolonian to these Middle and Lower Portlandian beds. On stratigraphical grounds it does not appear possible for us to adopt this term, and on the whole the following grouping appears best adapted for the English strata:—

Upper Portland Beds—Portland, Tisbury and Swindon Stone.
Lower Portland Beds—Portland Sands and Hartwell Clay.

It is true that at Swindon and Hartwell the Lower Portland Beds are more intimately connected, on stratigraphical grounds, with the Kimeridge Clay than with the Upper Portland Beds; but this is not the case on the Dorsetshire coast, where no conglomeratic band has been met with at the base of the Portland Stone.

V.—Further Note on the Midford Sands.[1] By Horace B. Woodward, F.G.S., of the Geological Survey of England and Wales.

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THE term Midford Sands, introduced in 1871 by Professor Phillips, has been accepted by many geologists because it avoided the confusion that had arisen from the use by some authorities of the term Inferior Oolite Sands, and by others of Upper Lias Sands.

At Midford the upper portion of the Inferior Oolite (zone of *Ammonites Parkinsoni*) rests directly on the Sands, whereas in other parts of Somersetshire, in Dorsetshire and Gloucestershire, the lower portion of the Inferior Oolite (comprising the zones of *A. Humphriesianus and A. Murchisonæ*) is present above the Sands. In the absence of palæontological evidence, it has been questioned whether the Midford Sands are really equivalent to the Sands in other parts of the south-west of England. Hence other local names, *e.g.* the Yeovil and Bridport Sands, and the Cotteswold Sands, have been introduced.

Regarding the zone of *Ammonites opalinus* and the Gloucestershire Cephalopoda-bed as a portion of the Cotteswold Sands, there is no doubt about their correlation with the Sands of Bridport and Yeovil. Two species of *Ammonites* (*A. striatulus* and *A. aalensis*) have been obtained by the Rev. H. H. Winwood from the Midford Sands. The latter of these species was recorded by myself, on the authority of Mr. Etheridge, in 1876, but its occurrence has been overlooked. More recently I have seen in the William-Smith Collection in the British Museum, an *Ammonite* from the Coal-canal at Midford; and this has been identified by Mr. Etheridge and Mr. R. B. Newton, as very near to, if not identical with *A. Levesquei*, a species recorded by Dr. Lycett from the Gloucestershire Cephalopoda Bed. These species show that the Midford Sands belong to the same general horizon as the Sands of Gloucestershire and Dorsetshire, so that there is no adequate reason for discarding the name Midford Sands. If the beds near Bath have not proved so fossiliferous as those in other localities, there is no reason why they should remain so; for in Dorsetshire there are many sections where the beds appear barren, in close proximity with other exposures that yield an abundant fauna.

[1] A previous Note on the Midford Sands was published in the Geological Magazine, 1872, p. 513.

VI.—On *Bucklandium diluvii*, König, a Siluroid Fish from the London Clay of Sheppey. By A. Smith Woodward, F.G.S.

In his well-known 'Icones Fossilium Sectiles,' pl. viii. No. 91, König figures a remarkable fossil from the London Clay of Sheppey, which is mentioned in the text as not certainly determinable, but generally regarded, by the anatomists who have examined it, as pertaining to some type of Lizard. This specimen is preserved in the British Museum, and the author has determined that it is truly the imperfect head and pectoral arch of a Siluroid. The roof of the skull is preserved almost as far forwards as the middle of the frontals; the pectoral arch is in position, though slightly bent backwards; and the mass of anchylosed anterior vertebræ, with the basioccipital, is displaced downwards and thrown beneath the clavicles. All the bones are remarkably strong, and the exposed surfaces are ornamented with large tubercles. The head must have been originally somewhat deeper than broad, and the roof exhibits no flattening, but is strongly arched from side to side. Posteriorly, the supra-occipital projects in the usual manner, probably to meet a dermal plate upon the nape; and the post-temporal element seems to be merged with the bones of the postero-lateral angles of the cranium. It is impossible to determine the family-position of the genus in the usual manner, but the skulls of the West African *Auchenoglanis* and *Synodontis* appear to approach the fossil most closely. The provisional name of *Bucklandium diluvii* may be retained; and the fish is interesting as being the earliest undoubted Siluroid hitherto discovered.

VII.—A Comparison of the Cretaceous Fish-fauna of Mount Lebanon with that of the English Chalk. By A. Smith Woodward, F.G.S., F.Z.S.

No detailed comparison having hitherto been instituted between the Cretaceous fish-fauna of Mount Lebanon and that of the English Chalk, which belongs to a well-determined horizon, the author has undertaken a general survey of the genera, with the result that the two faunas are proved to have more forms in common than hitherto supposed. The Selachian fishes are scarcely comparable, *Notidanus* and *Squatina* being the only genera as yet recognized in the two formations; and, on the whole, those of Mount Lebanon exhibit the most modern facies, all traces of Hybodont Sharks and of *Ptychodus* being wanting. Chimæroids are unknown at Mount Lebanon, but abundantly met with in the English Chalk. Among Ganoids there are representatives of the Pycnodonts both in the Lebanon (*Palæobalistum*, *Coccodus*, *Xenopholis*) and in England (*Cœlodus*), but no identical genera can yet be recognized. Rhombic-scaled Ganoids are rare in the English Chalk (*Lophiostomus*, *Neorhombolepis*), and unknown in Mount Lebanon; traces of Acipenseroids also occur in the former, but have not been discovered in the latter; and at least one Crossopterygian genus occurs plentifully in England (*Macropoma*), while no uncertain remains have been

detected in the Syrian beds. *Belonostomus*, however, is common to the two formations, one species having been described from Mount Lebanon under the name of *Rhinellus laniatus*.

Of Physostomous Teleosteans, the great early families represented in the Chalk of England and the Upper Cretaceous of North America by *Portheus*, *Ichthyodectes*, *Protosphyræna* and *Pachyrhizodus*, are quite unknown in the deposits of Mount Lebanon; but in the latter locality *Enchodus* is abundant, having been described under the synonym of *Eurygnathus*, and this is accompanied by a closely-allied genus, *Eurypholis*, only differing in the possession of a few dermal scutes. The English *Pomognathus* may also be regarded as represented at Mount Lebanon, for the so-called *Phylactocephalus* merely differs in the presence of extremely delicate minute scales, which would not be preserved in a matrix of the nature of the Chalk; and *Aspidopleurus* (Mount Lebanon) possesses scutes indistinguishable from the detached examples long known in the English Chalk under the name of *Prionolepis*. *Dercetis*, also, is met with abundantly in the Syrian beds, being described under the synonym of *Leptotrachelus*. Among Elopine Clupeoids, some undescribed forms occur in the English Chalk, and one from Mount Lebanon has been erroneously assigned to the genus *Clupea* (*C. Lewisii*); and the supposed Salmonoid, *Osmeroides*, is common to the two formations, though inferior in size at the last-named locality. In the Syrian deposits, however, there are many more specialized Physostomi, such as *Cheirothrix*, *Spaniodon*, *Opistopteryx*, *Rhinellus*, *Scombroclupea*, *Diplomystus*, and *Clupea*, not represented among English Chalk fossils. Among Physoclystous Teleosteans but few genera are common to the two formations under comparison. *Hoplopteryx*, with perhaps *Beryx*, represents the Berycidæ in both localities; but only a single imperfect specimen from the English Chalk can yet be assigned to any higher type, namely, *Platax* (?) *nuchalis*. At Mount Lebanon more specialized Physoclysti are numerous, as *Platax*, *Imogaster* and *Pycnosterinx*; although to the latter have been erroneously assigned certain extraneous forms, including at least one well-marked Berycoid, the so-called *Pycnosterinx Lewisii*.

The conclusion is thus arrived at, that in those respects in which the Lebanon fish-fauna differs from that of the English Chalk, it exhibits greater specialization. Considered alone, therefore, it is distinctly of a more modern type than the latter, although the beds in which it occurs are regarded, from other evidence, as being of Senonian or even Turonian age.

VIII.—On the Recent Volcanic Structure of the Azorean Archipelago. By Osbert H. Howarth.

THE object of the author's notes upon the relation of the Azorean group to the other islands of the West Atlantic is to indicate a line of inquiry by which some approximation may be made to the intervals separating the great eruptive changes; and determining any modifications in the type of flora during that important succes-

sion of volcanic products, which has been evolved since the Upper Miocene period assigned to the islands generally. A field for such inquiry seems to be offered by the present phase of action in the Furnas district, in the eastern centre of St. Michael's, where existing activity is associated with some of the oldest formations in the series. The author has traced in that valley a series of beds of vegetable origin dating back from the most recent changes, immediately connected with the present boiling-spring area, to a period antecedent to the formation of the Furnas Valley itself. The intermediate intervals of repose are now represented by peaty beds and subaqueous vegetable deposits, interstratified with the successive lava streams, tuffs, and pumice beds of various dates, within and prior to the historical period. From the more recent of these, buried trunks and branches have been obtained which represent the intervals of recent eruptions; while in one of the older tuffs, underlying nearly the whole series at that portion of the islands, a tree (probably an *Erica*) has been found, presumably *in situ*, and offering possibilities of a subjacent soil for examination, which would be contemporaneous with the earliest vegetation of the island.

IX.—The Volcanoes of the Two Sicilies. By Tempest Anderson, M.D., B.Sc.

THE author has recently visited the volcanoes of Naples, the Lipari Islands and Sicily, including Vesuvius, Stromboli, Vulcano and Ætna, and taken photographs of their craters and some of their lava streams, and other most important parts, in order to obtain a record of their present condition which may be available for comparison in case of future eruptions. Some of these photographs were shown as projections on a screen by means of a lime-light lantern.

REVIEWS.

The Building of the British Isles: A Study in Geographical Evolution. By A. J. Jukes-Browne, B.A., F.G.S. Sm. 8vo. pp. 335, with Maps and Woodcuts. (George Bell & Sons, 1888.)

ONLY a few years have elapsed since the late John Richard Green, combining physical geography, archæology, and history in the most happy manner, presented his fellow-countrymen with that admirable story in the development of their race, entitled "The Making of England." We are now presented with an equally interesting volume of physical history, and somewhat wider geographical scope, in which is told the story, how and during what geological periods the British Isles were built. Just as the modern English are a remarkable mixture of many races, so are the British Isles, as every geologist knows, a most remarkable epitome of the physical history of the Earth's crust, our limited territory being in fact like Jacob's coat in respect of the variety of the pieces which go to make it up.

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Thus the story of the "Building of the British Isles" involves to a considerable extent the history of most of the geological formations. To write a book of this kind successfully requires peculiar qualifications, and certainly no one is entitled to attempt the task who does not possess a tolerably intimate acquaintance with the geology of Western Europe, a fair share of the imaginative faculty and good literary abilities. To these it will be generally conceded that the author may fairly lay claim, and we must now proceed to consider what use he has made of them in the work before us.

The study of geographical evolution has had many votaries, both in this and in other countries. The early efforts of Godwin-Austen in this direction have been singularly confirmed by the deep borings made of late years in the Eastern and Midland Counties. Indeed, it is the frequency with which the Neozoic rocks have been probed in so many localities—mostly in search of water, more rarely to find coal—which enables the modern geologist to lay down with tolerable accuracy the suberranean surface of the Palæozoic rocks. We have a good summary of these results, as applied to a certain line of country, in the diagram-section (p. 115), from the valley of the Severn to the valley of the Lea. [N.B.—A more clearly defined sea-level line would improve this section.] The information thus acquired provides the means by which it is possible to reconstruct the Mesozoic geography of a large part of England with a tolerable degree of probability. There is just one terrible factor in the account which must present itself to every one who attempts geographical restoration from geological data, viz. the imperfection of the geological record. This the author admits with a candour which is in good keeping with the general sobriety of the book. "In some instances," he says, "the facts which are known suggest different inferences to different minds, and there are several cases in which different views are held with regard to a certain area having been above or below water during a certain period. In such cases I have carefully examined the different views which have been taken by those who have written on the subject, before selecting that which appeared to be the most probable interpretation of the facts."

The plan of the book is as follows. He gives a summary of the stratigraphical evidence of each period, followed by a geographical restoration, which is further exemplified by a map, in which the present outline of the British Isles is indicated by a red line, whilst horizontal blue lines represent the area which is supposed to have been covered by water during the successive periods. There are fifteen of such maps, plates xii. xiii. and xiv. being drawn on a smaller scale so as to include Iceland and parts of the west coast of the Continent and Norway. The following periods are recognized:—The Cambrian, Ordovician, Silurian, Old Red or Devonian, Carboniferous, Permian, Triassic, Jurassic, Cretaceous, Hantonian (Eocene and Oligocene), Icenian I. (Miocene and Pliocene), Icenian II. (Pleistocene). Then follows a summary of the geographical evolution of the British Isles, and in the last chapter he discusses the theory of the permanence of oceans and continents.

"At present," he admits, "that the maps of early Palæozoic geographies are only pictorial representations of the ideal views which are suggested to our minds by the inferences obtained from the study of a few small and disconnected areas." This is perhaps a somewhat off-hand way of describing the earlier Palæozoics of our country, but he is perfectly right in attaching no particular value to such restorations. Pre-Carboniferous geography is very much a matter of fancy, and we bear in mind the old saying "*De gustibus non est disputandum.*" One feature in these early speculations seems to enforce itself, viz. the unwillingness of the west part of Anglesey to go under water. Both in the Arenig and Llandovery epochs this obstinate little island refused to be entirely submerged. The same was the case in Lower Devonian times. Even during the epoch of the Carboniferous Limestone the north-west corner is represented as being still unsubmerged. Surely it is Anglesey, and not Kent, which should inscribe "*invicta*" on her escutcheon. This was connected with a block of very old land on the site of St. George's Channel, including a strip of Eastern Ireland, which seems to have been a sort of "*omphalos*" of the British Islands. The central portions of this block are represented as being land in every one of the fifteen maps except the last, though we presume that the author regards it as having been covered during the great submergence of the Chalk epoch.

When we try to restore the geography of the Carboniferous period, there is already something more definite to formulate, and "we can point to districts which seem to be the worn-down remnants of Carboniferous land tracts." No one can dispute this, but is there such good proof that at this period "there was more land than water where the Atlantic now rolls"? This is rather a strong statement for so cautious and conscientious a writer as Mr. Jukes-Browne. He regards the "continent" to which the Palæozoic nucleus of our islands was subsidiary as lying to the north and north-west of the British area. This "Continent" can be no other than the hypothetical Atlantis, a creation of the period when oceanography was in its infancy. He perceives the unfavourable bearing of this assumption upon the general principles of physical evolution, and explains that probably the seas and continents of the Palæozoic world had an evolutionary history of their own, which culminated in the geographical conditions of the Carboniferous period. His views are more fully set forth in the last chapter, where he discusses "the theory of the permanence of Continents and Oceans." No doubt he will have many opponents, and it is evident that, henceforth, there will be two schools of geographical Evolution, and that the results will vary materially according to which of these two schools an author may happen to belong.

Reverting once more to the main subject of the book, every geologist is aware that, however much of the older rock material had been roughly fashioned before the upheaval of the Carboniferous deposits, yet the building of the British Isles only commenced in earnest during the interval which succeeded the close of this period. Then were traced the main outlines of the skeleton of Palæozoic

rocks upon whose stony flanks and platforms the softer Neozoic deposits were to be thrown down, these latter also to be hardened, raised up and sculptured in their turn. The Permian deposits may perhaps help to throw some light on the latter part of this revolutionary interval, since their fauna is linked with that of the preceding age, although their physical relations to the older rocks are of the most discordant character.

We have now arrived at a time in geographical restoration when it is possible to speculate with some chance of being correct. Plate v. introduces us to the geography of the Permian period. The area is mostly land: an impounded water-space lies to the west of the Pennine chain, whilst on the east the Magnesian Limestone Sea is extended indefinitely across the central portion of the North Sea area, as though it might possibly still communicate with an ocean. The next plate represents the period of the Keuper, the continental phase still predominating in this area. A lake of curious shape extends from the Gulf of Normandy across the west centre of England until it is split by the Pennine mass into a north-eastern and a north-western area. This no doubt would be highly saline. Subsidiary basins, presumably of fresh water, occupy a southerly prolongation of the Minch and the Moray Firth. These two maps represent the great period of chemical precipitation in our area.

By the time of the Lias and Inferior Oolite the general lowering of the land had enlarged this water-space, which now appears as an arm of the sea with marine connections across the Paris basin, but retaining in no small degree the shape of the old Triassic lake. There are even rivers, one of which flows in from the west at a point in the Bristol Channel between the coasts of Devon and Wales. Another river flows into an estuary opposite Cleveland, and a third debouches a long way outside the Moray Firth. These two rivers are supposed to drain the continent to the north-east; the embouchure in each case is within the area of what is now the North Sea, and consequently not accessible to close examination. Within the limits of the map there is a considerable preponderance of land. Premising that nearly the whole of the North Sea and the North Atlantic is represented as being land, the following blocks may be distinguished in addition: (1) the Highlands north of the Great Glen; (2) the bulk of Scotland with its continuations in the Pennine chain and towards the Isle of Man; (3) nearly the whole of Ireland; (4) Wales; (5) the Damnonian Peninsula; (6) the Palæozoics of Kent and East Anglia. It was these lands, and more especially the recently exposed Carboniferous, which provided the bulk of the Jurassic sediments. The view that the Jurassic clays were largely derived from the denudation of Coal-measure shales found an able exponent, some years ago, in Prof. Blake. It is doubtful if much was derived from the hypothetical East Anglian land.

Mr. Jukes-Browne considers that, allowing for oscillations at various times and in different places, the area continued to sink throughout the Jurassic period, and he does not hold the opinion, so

generally adopted, that the Oxfordian epoch represents the period of maximum depression, although he allows that a large part of the eastern land was submerged during the formation of the Oxford clay. "The episode of the Corallian beds," he says, "marks a time when from some cause the deposition of mud ceased over certain parts of the sea-bottom, and the water became clear enough for the growth of coral reefs." He concludes that this represents a pause in the general subsidence. Such an explanation will only suit some districts, because the Corallian limestones, etc., have their argillaceous equivalents over considerable areas. We are inclined to think that the Oxfordian beds do, on the whole, represent the most extensive and regular depression of Jurassic time in our own and neighbouring areas, that the Corallian beds indicate, as the author says, a pause, but one of irregular distribution, and that the Kimmeridge Clay was deposited in an oscillating area—a supposition which can alone account for the extraordinary variation in its thickness and character within short distances.

These oscillations at length resulted in the restriction of the Jurassic water-spaces, such as must have occurred during the Portlandian epoch. This geography is represented in plate viii. The Portlandian Sea is open towards the Paris basin, and occupies only a portion of the South of England. A strip of water on the coast of Lincolnshire and East Yorkshire has an undefined connection with a gulf which points towards Germany, and there is the usual water-space to the south of the Isle of Man—admitted to be hypothetical. It is interesting to note that throughout the first half of Mesozoic time, dating from the Permian to the Portlandian, whilst the Atlantic is completely ignored, whilst of the North Sea and the English Channel there is not the slightest trace, yet the shallow Irish Sea is always represented as having been submerged. Certainly a boring in this area, if it were possible, should produce most interesting results. Permian, Triassic, Liassic, and Oolitic rocks, even to the Portlandian, ought there to be found in undisturbed sequence.

The remaining periods must be considered briefly. Omitting the stage of the Purbeck-Wealden, we find, when marine deposits once more take place, the two principal water-spaces of the Portlandian epoch, somewhat modified, are now connected by narrow straits in the East Midlands. This arrangement represents the Aptien (Lower Greensand) stage of the Lower Cretaceous (plate ix.). All else is land. Even the bed of the Irish Sea is at length brought up to day, and might thus lose some of its earlier Mesozoic deposits. But, since coming events cast their shadows before, a dubious outline of the Atlantic for the first time appears off the north-west coast of Ireland. This scene may be taken to represent the last stage of Mesozoic geography before the great submergence which ultimately brought the waters of the Chalk Sea over the area of the British Isles. The author does not venture to portray the great consummation, but plate x. represents the geography of the period when the basal sediments of the Chalk, *e.g.* Gault, Upper Greensand, etc., were creeping over England. The laying down of the probable

coast-line at this juncture is an interesting piece of work, and for much original information on this point we are indebted to the author himself, and to his friend, Mr. Hill. Parallel to this coast-line, but still separated from it by some 200 miles of the unsubmerged Britannic block, is the shadowy Atlantic ready to unite with the eastern sea. Even at this juncture nothing but land is represented to the north of Scotland and the south of Ireland.

Recalling the general views of the author as to the relations of land and sea within the area treated from the beginning of Mesozoic time to the eve of its closing scene, we are somewhat struck by the limited amount of water-space. The curious shape of the Keuperian reservoir, with its fresh-water adjuncts in the north-east and north-west of Scotland, is copied with singular fidelity by the seas of the Lias and Inferior Oolite, the only access to any ocean being a problematical one through the Paris basin. It is difficult to believe that such a thoroughly marine formation as the Lias was deposited in waters so stale as these must have been. We observe, too, that the author considers such a minor accident of the Earth's crust as the Great Caledonian Glen to have been already in existence, and yet he persists in ignoring the Atlantic basin, the eastern edge of which is quite as likely to have been a permanent feature. Moreover, we do not feel quite convinced of the existence of such a great mass of land to the north during Mesozoic times as is represented in all the maps. It is to be hoped that the Oxfordian seas were allowed a little more latitude in this direction.

Tertiary Geographies.—During the Lower Eocene period the Britannic block is represented as being all land to the west of a line between the Wash and Bridport Bay: the London Clay sea covers the rest. During Oligocene, and presumably during Miocene times, it merely forms part of a continental mass which extends from the Bay of Biscay to the Scandinavian Highlands. In the course of this lengthened exposure the carving of the British Isles must have made progress: the escarpments of the Secondary rocks would be roughly outlined, and the older rocks again touched up. "It is possible that some of the geological features of western and central England were initiated at this time" (p. 247). But Mr. Jukes-Browne considers that we cannot use the modern physical geography of the country as affording much assistance in the restoration even of early Pliocene geography, though he thinks that the German Ocean may have been initiated "in the latter part of what we call Pliocene time."

"That the close of the Pliocene epoch found the main physical features of England fully developed, and the Mesozoic escarpments occupying their present positions, we know from the relations of the Pleistocene (Glacial) deposits to these features." The wonderful change which had taken place during the latter part of the Pliocene is depicted in pl. xiii. As if by magic nearly everything is in its place. The German Ocean is an accomplished fact. Rivers drain the valleys which prefigure the English and St. George's Channels, and at length the Atlantic is permitted to mingle its waters with

those of the deep Norwegian basin. The river-system is, on the whole, similar to that which now exists, and we may fairly infer that the building of the British Isles was completed. All we can say is, that there must have been good workmen in later Pliocene times; for if these views are correct, considerably more than half the physical features of the British Isles, both geographical and hydrographical, date from this limited interval of geologic time.

In dealing with the final or Pleistocene stage, its abnormal climate, its submergences, and all the other enigmas of the Great Ice Age, the author avoids the extreme theories which find so much favour in some quarters. He allows that "the uncertainty which exists with regard to the real succession, and to the precise mode of formation of these Glacial deposits, makes it unsafe to attempt a geographical restoration of any of the several phases of the Glacial epoch." He prefers to select for illustration the period in Pleistocene time when the rigour of the Ice Age had moderated, and when the British region had emerged from the waters of the Glacial Sea. The bed of the German Ocean is now so filled with *débris* that "the upheaval necessary to convert this sea into land after the Glacial period was 100 fathoms less than would have been required to effect the same result in later Pliocene time." An extension of the Rhine meanders through the great plain, to which the rivers of Eastern England are tributary. This represents the epoch when the coast-line of Western Europe coincided with the 80 fm. contour. Subsequently the water gains on the land, these low-lying tracts are destroyed, and our narrow seas are being cleaned out. The last great geographical touch was given when the tidal waters, assisted perhaps by depression, eat their way across the low water-shed of two river-valleys which is now marked by the Straits of Dover.

We have followed Mr. Jukes-Browne with much pleasure through this very interesting study in geographical evolution, and can strongly recommend it to the attention of all geologists and physical geographers. In a case of this sort it is far easier to criticize than to construct, and no doubt each specialist could find something to suggest in every stage of the process from the earliest Palæozoics to the latest Pleistocene times. Many points, also, in ancient geographies must for ever remain mere matters of opinion. What is especially to be commended in this book is its freedom from any extravagant ideas: the author has taken for his motto, *in medio tutissimus ibis*, and in this spirit has acted throughout.—W. H. H.

CORRESPONDENCE.

NOTE ON A GLACIAL BED IN BEDFORDSHIRE.

Sir,—The Lower Greensand forms a well-marked escarpment running parallel to that of the Chalk through Bedfordshire, and overlooking the flats consisting of Oxford and possibly Kimeridge Clay. About a mile from Ampthill in the direction of the ruined mansion at Houghton, quite on the edge of the escarpment, and facing the

north-west, there is a large pit worked for sand and gravel, which has apparently escaped attention, or at least description. The beds are obviously Glacial, and apparently coeval with the Boulder-clay, but the boulders and pebbles are cemented with greensand, and not with clay. The stratification is distorted, and discontinuous. The greatest depth of the section is about 35 feet, and the beds extend further beneath. Beginning from below, the layers are in one part as follows: loam, conglomerate of boulders, clay, conglomerate, sand, pebbles and half-rounded flints, sand, conglomerate, sandy subsoil; the thickness of each layer being three or four feet. The pebbles and fossils are of all ages, but flint, chalk boulders, and hard iron sandstone predominate. There are also fragments of lignite; Ammonites from the Oolite; Granite, and Igneous rocks. It is just possible that the beds have been deposited under the combined action of ice and rivers, but the beds in no way resemble the river-gravels of the Ouse. A layer of sand 3 or 4 feet thick, and about 25 feet in length, is absolutely free from pebbles, and is of a fine white texture, similar to that used for commercial purposes, and quarried from the Lower Greensand in many places. It looks as though it had been pushed or transported bodily, without any disturbance from the Greensand.

The conglomerate is extremely hard, and fractures occur across the contained pebbles like Hertfordshire pudding-stone. A search for flint implements proved, as was expected, futile.

This section thoroughly deserves a visit, and I should be glad to learn the opinion of geologists about its age and probable method of formation.

P.S.—Mr. Cameron, of H.M. Geological Survey, is of opinion that these beds are Middle Glacial.

A. S. Eve.

Marlborough College.

DISCOVERY OF A CIRRIPEDE IN CANADIAN PALÆOZOIC ROCKS.

Sir,—I have just received a communication from my friend Mr. Henry M. Ami, M.A., F.G.S., of the Geological Survey of Canada, dated Ottawa, 23rd August, 1888, in which he makes the following interesting announcement in a postscript:—

"Last Saturday afternoon, whilst collecting in the 'Siphonotreta' band [lower part of Utica Formation = Bala Limestone Group, in part] along the Rideau River—near the rifle range—I had the good fortune to come across what appears to be a fossil Cirripede, allied to *Turrilepas*. The group to which these ancient barnacles belong lies still in much obscurity; Darwin, Woodward, Lindström, Hall, and Clarke have written on them. I think this is the first time we have found any in Canada in Palæozoic rocks."

I have only to add that I expect shortly to receive the specimen from Mr. Ami for description.

Arthur H. Foord.

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